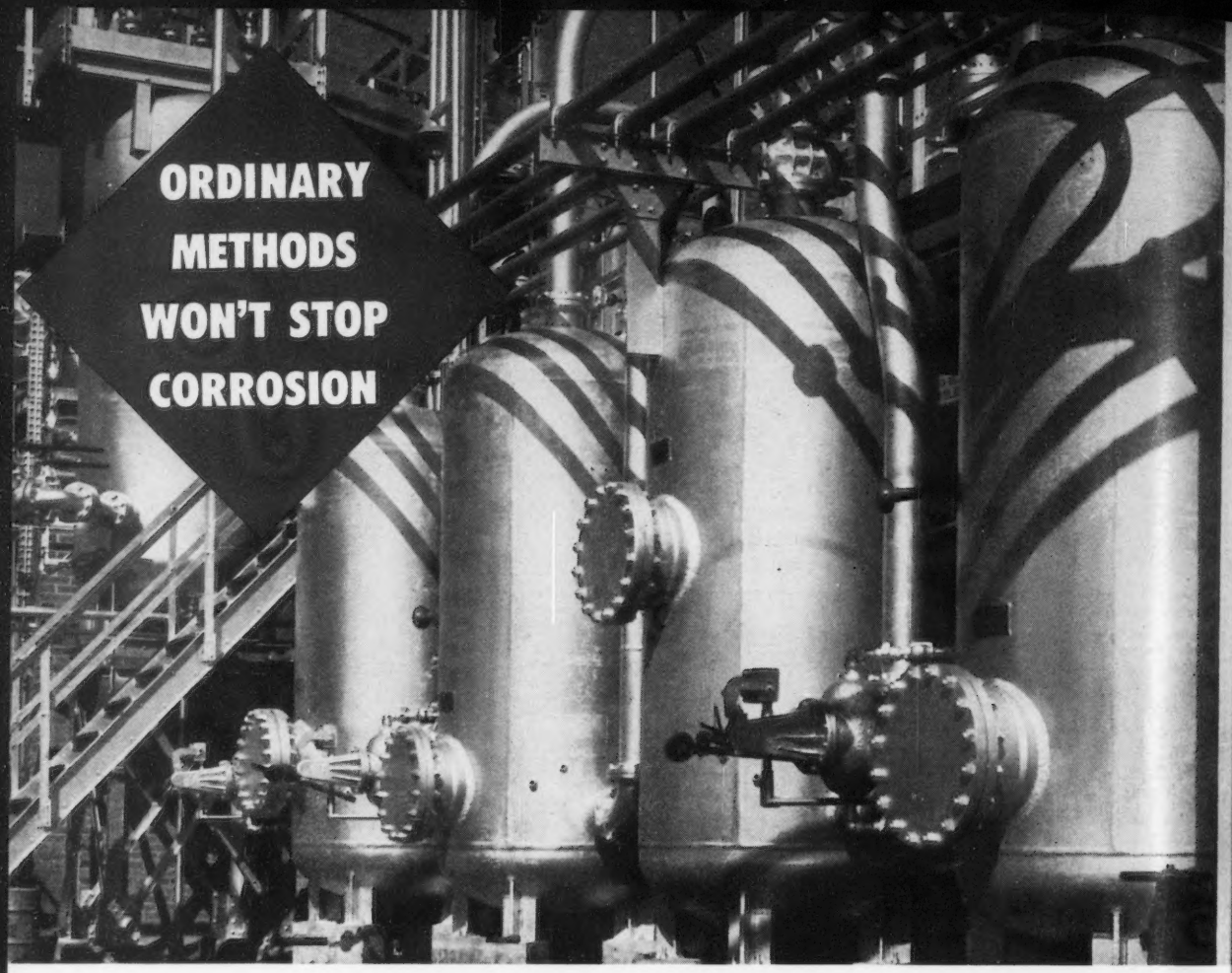
Corrosion



SPECIFY THE AMERCOAT METHOD— Designed to Give You *PLUS* PROTECTION

Ordinary methods for controlling corrosion usually produce the ordinary results—rapid paint failure, costly replacements, product contamination, excess down-time, and hampered production. Halfway measures and the use of one or two general purpose coatings simply cannot provide adequate protection against corrosion's ceaseless attack.

Amercoat gives you a proven method of corrosion control, assuring you proper protection through these PLUS features:

1. Careful analysis by a trained engineer of all the conditions present in each corrosion problem.

2. The ONE best recommendation for the particular problem. AMERCOAT is a complete line of coatings, each formulated to solve or control specific corrosion problems.

3. On-the-job assistance to your applicators and supervisors by a trained engineer. The AMERCOAT method ensures proper attention to surface preparation and application techniques for maximum protection.

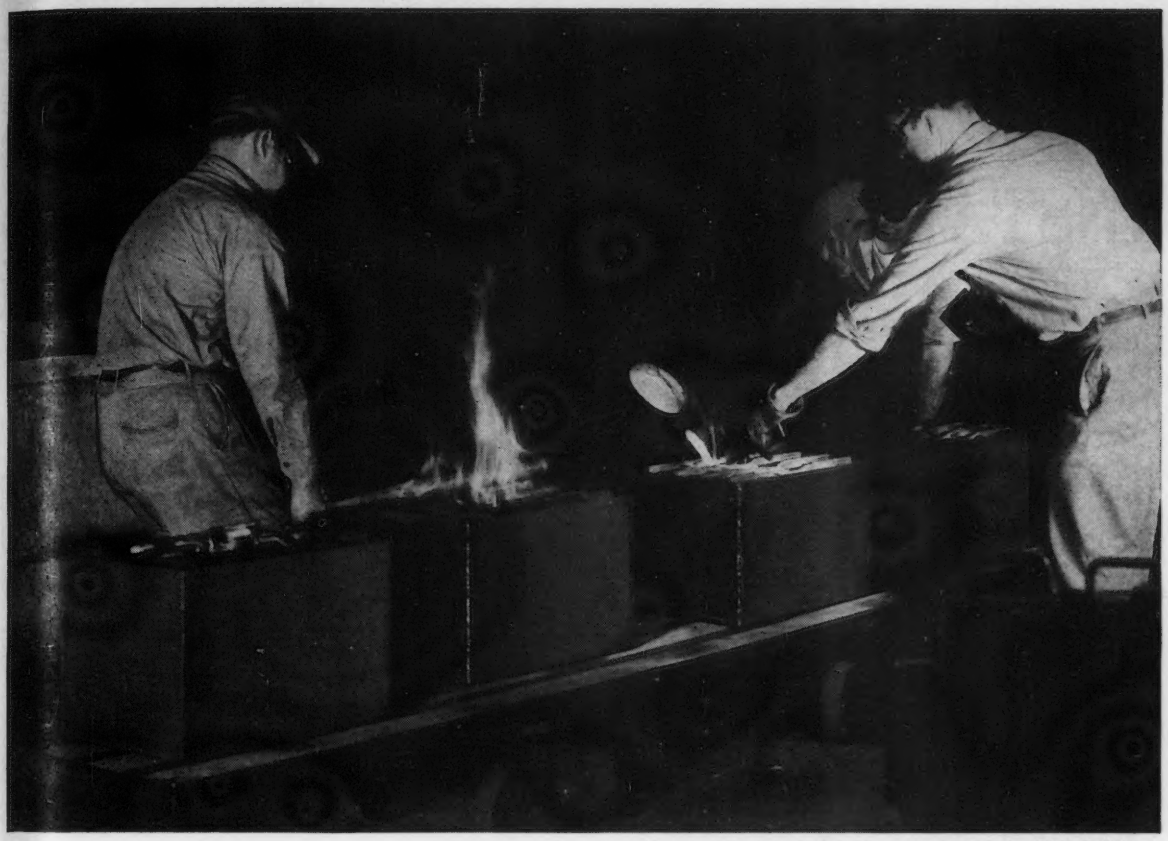
4. Complete stocks of fresh materials always near you at one of AMERCOAT's five regional warehouses or more than 20 franchised distributor warehouses throughout the United States.

5. Service based on experience. The AMERCOAT method of corrosion control is the result of nearly 20 years' experience in solving or controlling corrosion problems in every major industry throughout the United States.

Write today for the name and address of the AMERCOAT representative in your area. At no obligation, he will gladly help you analyze your corrosion problems and evaluate your present control measures. If it is determined that you have a problem within our scope of experience, he will outline a complete program of AMERCOAT's PLUS protection for your plant or equipment.

Amercoat CORPORATION

4809 Firestone Blvd.
South Gate, Calif.
Chicago,
Newark,
Jacksonville, Fla.
Houston, Texas



Pouring castings in shell-molds at Aloyco's foundry, Bloomfield, N. J.

ADD ANOTHER NEW JOB FOR *PLASTICS*

● Castings are being poured in shell-molds of sand and phenolic plastic here in the foundry where ALOYCO valves are made. This new process of shell-molding is much faster and produces castings of much closer tolerance than conventional molds.

These shell molds, like body armor for our soldiers, refrigerators that stay colder, lightweight X-ray splints, automobile bodies, boats, adhesives, coatings, pipes, and gears are among the many products recently made better or cheaper by plastics.

Almost half of our modern plastics are made by combining phenol with formaldehyde, using high temperatures and suitable catalysts. The resulting plastics are then molded by heat and pressure into finished products having virtually any desired properties.

ALOYCO valves made of Aloyco 20, Monel or nickel have proved to be especially effective in handling the corrosive sulphuric or hydrochloric acid catalysts, thereby protecting plastics from discoloration or contamination. Makers of today's myriad plastics, like so many other chemical processing industries, rely on ALOYCO valves to withstand corrosives encountered during the formation and subsequent treatment of their products.

Our practice of working out specific corrosion problems under actual line conditions, together with the long experience gained in producing corrosion-resistant valves exclusively, have made us the largest specialists in the field. ALOYCO valves go hand-in-hand with chemical progress.

If corrosives play a part in your business write to the *Aloyco Corrosion Engineering Service* about your own problems.

3.14

Longer Lasting
ALOYCO VALVES
1st in Corrosive Service

ALLOY STEEL PRODUCTS COMPANY, Inc.
1323 West Elizabeth Avenue, Linden, N. J.
Plants: Linden, N. J.; Bloomfield, N. J., Elizabeth, N. J.

DISTRICT OFFICES

NEW YORK 1, N. Y.
350 Fifth Avenue

WILMINGTON, DEL.
226 West Ninth St.

PITTSBURGH 22, PA.
318 Investment Bldg.

ATLANTA, GEORGIA
333 Candler Bldg.

ST. LOUIS, MISSOURI
1221 Locust St.

CHICAGO 4, ILL.
332 So. Michigan Ave.

HOUSTON 6, TEXAS
K. E. Luger Co.
2716 Danville St.

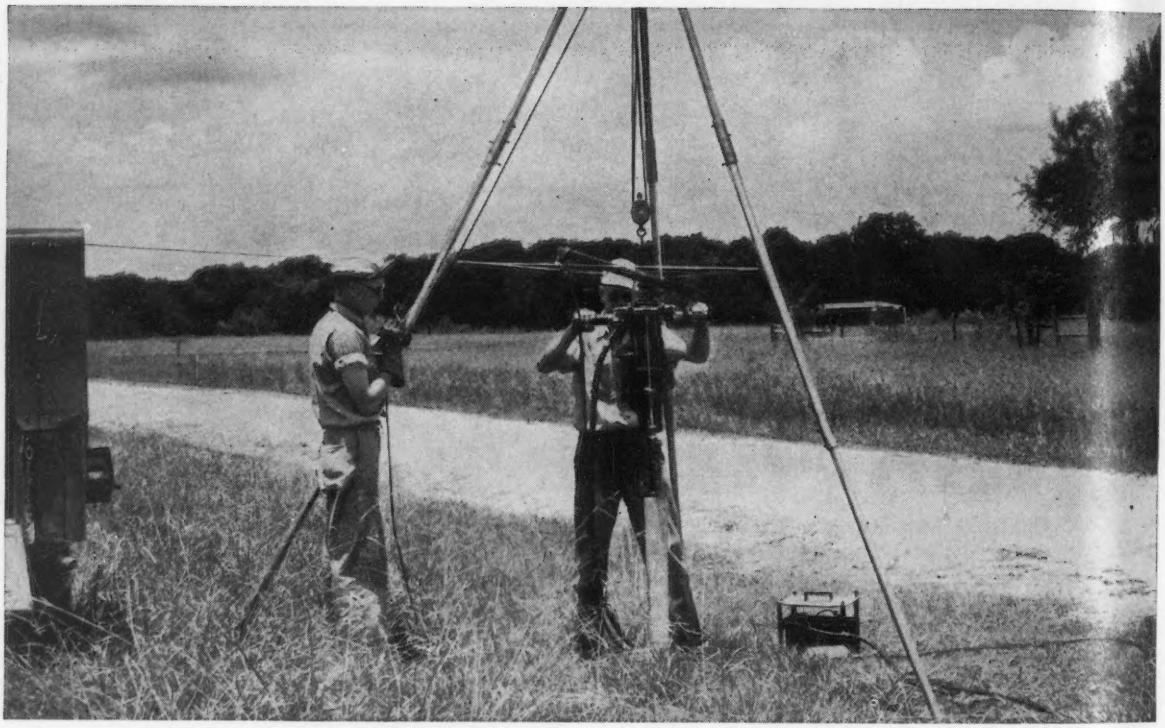
SAN FRANCISCO, CALIF.
24 California St.

LOS ANGELES 22, CALIF.
5442 Jillson St.

DOW

NEW MAGNESIUM ANODE CUTS INSTALLATION TIME AND COSTS

Galvo-Pile, latest DOW development, can be driven into ground, eliminating extensive installation equipment



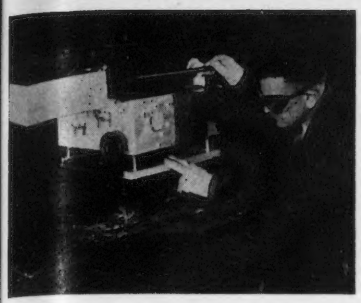
Now you can protect your underground equipment, pipelines and tanks easily, effectively and inexpensively with Galvo-Pile—the newest advancement in Magnesium anodes, developed by The Dow Chemical Company.

Tests made in various sections of the country show that Galvo-Pile is another effective item in the line of "tools" available for solving your corrosion problems. The elimination of backfill and the simple method used in driving this anode make it ideal in many locations, particularly in swamps and similar areas. Also, the savings in installation time alone will be of definite interest to you.

To help you determine the specific benefits of using Galvo-Pile for your cathodic protection assignments, call or write your nearest Dow sales office or authorized distributor. THE DOW CHEMICAL COMPANY, *Magnesium Department*, Midland, Michigan.

you can depend on DOW MAGNESIUM ANODES

DOW



THIS MONTH'S COVER—This machine is bonding a 6-inch strip of lead to prepared steel at the rate of a foot a minute. This 5-burner model is only one of the models of this device developed by Knapp Mills, Inc., 23-15 Borden Ave., Long Island City, N. Y., for quick application of lead coatings on metals. Besides being quicker the machine applied coating is more uniform than coatings applied by some other methods.

☆

EDITORIAL STAFF

IVY M. PARKER—*Editor*

EDITORIAL REVIEW COMMITTEE

THOMAS P. MAY, *Chairman*
GEORGE DIEHLMAN
I. C. DIETZE
J. J. HARWOOD
J. W. RYZNAR
ARTHUR W. TRACY
V. B. PIKE

CORRESPONDENTS

C. L. BULOW—*Non-Ferrous Metals*
R. W. FLOURNOY—*Pulp, Paper, Mining and Food*
J. J. HALBIG—*Ferrous Metals*
W. E. HUDDLESTON—*Petroleum Production and Pipe Lines*
HUGO W. WAHLQUIST—*Power*
W. B. BROOKS—*Chemical Process*
R. H. BROWN—*Light Metals*
C. F. POCACAR—*Petroleum Refining*
H. O. SAUNDERS, JR.—*Telephone, Telegraph, Radio*
R. MCFARLAND—*Non-Metals*
S. K. COBURN—*Transportation Industry*
T. E. LARSON—*Fresh and Salt Water*

BUSINESS STAFF

NORMAN E. HAMNER, *Managing Editor and Advertising Manager*
A. B. CAMPBELL *(Executive Secretary NACE) Business Manager*

GENERAL OFFICES

1061 M & M Building, No. 1 Main St.
Houston 2, Texas

Subscription: $9.00 per year to non-members: Member's dues $7.50, of which $3.75 are applied as subscription to CORROSION; Special rate, $4.00 per year for public libraries and libraries of educational institutions. Additional copies to members 50 cents, to non-members, $1.00. Foreign remittances should be by international postal or express money order or bank draft negotiable in the U. S. for an equivalent amount in U. S. funds. Entered as second class matter October 31, 1946, at the Post Office at Houston, Texas, under the act of March 3, 1879.

Corrosion Is Indexed Regularly by Engineering Index.

Corrosion

devoted entirely to CORROSION *research and control*

Published Monthly as its official journal, by the National Association of Corrosion Engineers, Inc., at Houston, Texas, U. S. A., as a permanent record of progress in corrosion control.

Vol. 9 JUNE, 1953 No. 6

CONTENTS

Page

Directory of NACE Regional and Sectional Officers ..... iv, v, vi

Directory of Technical Practices Committees ..... viii, ix

Officers and Directors, National Association of Corrosion Engineers xvi

TECHNICAL SECTION

Responses of 1953 NACE Award Recipients 191

Bacterial Corrosion of Offshore Structures
By J. A. Caldwell and M. L. Lytle 192

References on Plastics for the Corrosion Engineer
By Raymond B. Seymour 197

Studies on the Inhibition by Amines of the Corrosion of Iron By Solutions of High Acidity
By C. C. Nathan 199

Graphical Multiple Correlation of Corrosion Data
By O. B. Ellis 203

NACE REGIONAL AND SECTIONAL NEWS

Page

Two More Sections Authorized for NACE 2
Boston Section Elects Officers 2
McFarland Addresses Metropolitan Section 2
Air Conditioning Water Corrosion Is Discussed 2
Pittsburgh Sounds Out Members on Program 2
New England Section Hears Vandervalk 2
Southwestern Ohio Section Nominates 3
Two Papers Will Be Given at San Diego 3
Permian Basin Seeks Advice on Holding Corrosion Tour in West Texas 4
M. J. Olive to Speak 5
Pittsburgh Section 7

GENERAL NEWS OF CORROSION INTEREST

Page

Topic of the Month—Cooperative Corrosion Protection Benefits Miami Utilities
By D. T. Rosselle 1
Book Reviews 4
Lightweight Mobile X-Ray Developed 4
Pipe Lost in Gulf Found With Locator 4
NACE Cooperates in Corrosion Courses 5
A. J. Liebman Heads TP-6 5
Alloy Casting Institute Seeks Fundamental Knowledge 6
ASTM to Hear Papers on Corrosion 6
Marine and Titanium Corrosion Papers to be Heard 7
Maitland Succeeds to TP-6B Chairmanship 7
Bilhartz Accepts Post 7
International Group to Meet 7
Kansas City Technical Program Is Outlined 8
Sline Heads TP-6B 8
Orientation of Monel Metal Crystals Can Be Determined With Polarized Light 9
NBS Tests Indicate Corrosion Rate In Soil Is Measurable Electrically 12
New Products 16

INDEX TO CORROSION ABSTRACTS 27

INDEX TO ADVERTISERS 61

Copyright 1953 by the National Association of Corrosion Engineers. Reproduction of the contents, either as a whole or in part, is forbidden unless specific permission has been obtained from the Editor of CORROSION. Articles presented represent the opinions of their authors, and not necessarily those of the Editors of CORROSION, nor the Officers or Members of the National Association of Corrosion Engineers. Manuscripts to be considered for publication should be forwarded, together with illustrations, to the Editor of CORROSION, 1061 M & M Building, Houston 2, Texas.

Directory of NACE Regional and Sectional Officers

NORTH EAST REGION

L. B. DONOVAN, Director
Consolidated Edison Co.
of New York, Inc.
4 Irving Place
New York City.

GEORGE E. BEST, Chairman
Mutual Chem. Co. of America
1348 Block St.
Baltimore 31, Md.

KEMPTON H. ROLL, Vice-Chair.
Lead Industries Assoc.
420 Lexington Ave.
New York 17, N. Y.

W. R. BRIGGS, Sec.-Treas.
W. A. Briggs Bitumen Co.
3303 Richmond St.
Philadelphia 34, Pa.

• Baltimore Section

L. G. VON LOSSBERG, Chairman
Sheppard T. Powell Consulting
Chemical Engineers
330 North Charles Street
Baltimore, Maryland

ALLEN L. ALEXANDER, Vice-Chair.
1710 Oakcrest Drive
Alexandria, Virginia

RISQUE BENEDICT, Sec.-Treas.
Naval Research Laboratory
Washington 25, D. C.

• Greater Boston Section

JOHN SWIFT, Chairman
A. D. Little, Inc.,
30 Memorial Drive
Cambridge, Mass.

A. ORMAN FISHER, Vice-Chair.
Monsanto Chemical Co.
Everett Station
Boston, Mass.

J. DWIGHT BIRD, Sec.-Treas.
The Dampney Co.
1243 River, Hyde Park
Boston, Mass.

• Kanawha Valley Section

A. C. HAMSTEAD, Chairman
Carbide and Carbon Chemical Co.
South Charleston, W. Va.

R. I. ZIMMERER, Vice-Chair.
Westvaco Chemical Div.,
Food Machinery & Chemical Corp.
Drawer 8127, South Charleston,
W. Va.

CONRAD L. WIEGERS, Secretary
Allied Services Inc.
Spring & Bullitt Sts.
Station A, Charleston, W. Va.

W. R. CURLEY, Treasurer
Hope Natural Gas Co., Box 1951
Clarksburg, W. Va.

• Metropolitan New York Section

GEORGE C. HULL, JR., Chair.
Anglo-American Varnish Co.
55 Johnson St.
Newark 5, N. J.

MORTON BERMANN, Vice-Chair.
Brooklyn Union Gas Co.
197 St. James Place
Brooklyn, New York

F. J. LeFEBVRE, Sec.-Treas.
Electro Rust-Proofing Corp.
Box 178
Newark 1, N. J.

• Philadelphia Section

E. G. BRINK, Chairman
American Viscose Corp.
Marcus Hook, Pa.

H. H. BENNETT, Vice-Chair.
Socony-Vacuum Oil Co., Inc.
Paulsboro, N. J.

J. S. PETTIBONE, Sec.-Treas.
Am. Soc. Testing Mat.
1916 Race St.
Philadelphia 3, Pa.

• Pittsburgh Section

N. P. PEIFER, Chairman
Manufacturers Light
& Heat Co.
800 Union Trust Bldg.
Pittsburgh 19, Pa.

N. T. SHIDELER, Vice-Chair.
Pittsburgh Coke & Chemical
Corporation
Neville Island,
Pittsburgh 25, Pa.

F. E. COSTANZO, Sec.
Manufacturers Light &
Heat Company
2202 Vodeli St.,
Pittsburgh 16, Pa.

W. W. BINGER, Treasurer
Aluminum Co. of America
Research Laboratories
Box 772
New Kensington, Pa.

• Southern New England Section

F. R. MEYER, Chairman
Sou. New England Tel. Co.
New Haven, Conn.

A. W. TRACY, Vice-Chair.
American Brass Company
Waterbury, Conn.

GERALD R. BROPHY, Sec.-Treas.
International Nickel Co., Inc.
75 Pearl St.
Hartford, Conn.

• Western New York Section

WILLIAM O. BINDER, Chair.
Research Laboratories
Union Carbide & Carbon Corp.
Niagara Falls, N. Y.

J. E. SHIELDS, Vice-Chair.
Alox Corp.
3943 Buffalo Ave.
Niagara Falls, N. Y.

PAUL R. GUENTHER, Sec.-Treas.
Socony-Vacuum Oil Co., Inc.
503 Elk Street
Buffalo 5, N. Y.

NORTH CENTRAL REGION

WALTER R. CAVANAGH, Director
Parker Rust Proof Company
2177 E. Milwaukee St.
Detroit, Michigan

JACK H. LaPRETE, Chair.
Spray-Coat Engineers
775 S. Bayside St.
Detroit 25, Mich.

NORMAN A. KERSTEIN, Vice-Chair.
16817 Robson
Detroit, Michigan

JAMES F. HIRSHFELD, Sec.-Treas.
Hinchman Corp.
1208 Francis Palms Bldg.
Detroit 1, Mich.

• Chicago Section

C. A. VAN NATTA, Chairman
Plastic Lining Coatings
900-02 South Wabash Ave.
Chicago 5, Ill.

L. W. EWING, Vice-Chairman
Standard Oil Co. of Indiana
Pipe Line Dept.
910 Michigan Ave.
Chicago, Ill.

R. I. LINDBERG, Sec.
Sinclair Research Laboratories,
Inc.
400 E. Sibley Blvd.
Harvey, Ill.

H. W. DIAMOND Treas.
Morton Salt Co.
120 S. LaSalle St.
Chicago, Ill.

• Cleveland Section

C. N. DETRICK, Chairman
Williams & Co., Inc.
3700 Perkins Ave.
Cleveland, Ohio

W. E. BAKER, Vice-Chair.
Standard Oil Co. of Ohio
606 Standard Bldg.
Cleveland 13, Ohio

H. W. HOSFORD, JR., Sec.-Treas.
Harco Corp.
Box 7026
Cleveland 28, Ohio

• Detroit Section

L. D. COOK, Chairman
Wyandotte Chemical Corp.
Wyandotte, Mich.

W. R. CAVANAGH, Vice-Chair.
Parker Rust Proof Co.
2177 East Milwaukee
Detroit, Mich.

D. F. FINLAY, Secretary
Hinchman Corporation
1208 Francis Palme Bldg.
Detroit, Mich.

P. G. COATES, Treasurer
Michigan Bell Telephone Co.
312 Potawatomi Blvd.
Royal Oak, Michigan

• Eastern Wisconsin Section

ROBERT E. WICEN, Chair.
Chain Belt Co. of Milwaukee
1600 West Bruce St.
Milwaukee 4, Wis.

ROBERT A. HUSEBY, Vice-Chair.
A. O. Smith Corp.
3533 North 27th St.
Milwaukee, Wis.

HAROLD F. HAASE, Sec.-Treas.
2917 West Juneau Ave.
Milwaukee 8, Wis.

• Greater St. Louis Section

CAMDEN A. COBERLY, Chairman
316 Oak Manor Lane
Webster Groves 19, Mo.

WILLIAM J. RIES, Vice-Chair.
Tretolite Company
St. Louis 19, Mo.

ROBERT D. SANFORD, Secretary
Nooter Corporation
1400 South Second St.
St. Louis 4, Mo.

DONALD H. BECKER, Treasurer
Reilly Tar & Chemical Corp.
P. O. Box 370
Granite City, Illinois

• Kansas City Section

L. F. HEVERLY, Chairman
Great Lakes Pipeline Co.
5425 Chadwick Rd.
Kansas City, Mo.

R. A. KELLEY, Vice-Chairman
Minnesota Mining & Mfg. Co.
4224 West 73rd Terrace
Prairie Village, Kans.

J. C. BERRINGER, Sec.-Treas.
Panhandle Eastern Pipe Line Co.
1221 Baltimore Ave.
Kansas City, Mo.

Directory of NACE Regional and Sectional Officers

• Southwestern Ohio Section

ROY O. McDUFFIE, Chairman
Dept. Chem. & Met. Eng.
University of Cincinnati
Cincinnati 21, Ohio

ARTHUR D. CASTER, Vice-Chair.
38 Arcadia Place
Cincinnati, Ohio

LEWIS M. LEDERER, Sec.
Inner-Tank Lining Corp.
1097 Wade St.
Cincinnati, Ohio

R. L. WOOD, Treasurer
323 Plum St.
Cincinnati, Ohio

SOUTH EAST REGION

E. D. McCAULEY, Director
American Cast Iron Pipe Co.
Box 2603
Birmingham, Alabama

JOHN B. WEST, Chairman
Chicago Bridge & Iron Co.
1818 Rhodes-Haverty Bldg.
Atlanta, Ga.

H. C. VAN NOUHUYS, Vice-Chair.
Southeastern Pipe Line Co.
Box 1737
Atlanta, Georgia

DAVID H. CHADWICK, Sec.-Treas.
Res. Dept, Phosphate Div.
Monsanto Chemical Co.
Anniston, Ala.

• Atlanta Section

J. FLYNN JOHNSTON, Chair.
American Tel. & Tel. Co.
1139 Hurt Bldg.
Atlanta, Ga.

RAYMOND F. TRAPP, Vice-Chair.
3431 Sherman Road
Hapeville, Ga.

ALEX M. ERGANIAN, Sec.-Treas.
Pipe Line Service Corp.
1734 Candler Bldg.
Atlanta, Ga.

• Jacksonville (Fla.) Section

HENRY T. RUDOLF, Chairman
Atlantic Coatings Co., Inc.
P. O. Box 2976
Jacksonville 3, Fla.

P. E. ALEXANDER, Sec.-Treas.
Dozier & Gay Paint Co.
P. O. Box 3176, Station F
Jacksonville, Fla.

SOUTH CENTRAL REGION

DERK HOLSTEYN, Director
Shell Oil Company
Box 2527
Houston, Texas

H. E. WALDRIP, Chairman
Gulf Oil Corp.
5311 Kirby Drive
Houston, Texas

H. L. BILHARTZ, Vice-Chairman
Atlantic Refining Company
Box 2819
Dallas, Texas

CLIFFORD L. BARR, Sec.-Treas.
Shell Oil Company,
Richards Building
New Orleans, La.

JOHN E. LOEFFLER,
Asst. Sec.-Treas.
Thornhill Craver Co.
Box 1184
Houston, Texas

• Central Oklahoma Section

DAN H. CARPENTER, Chairman
Sohio Petroleum Co.
1300 Skirvin Tower
Oklahoma City, Okla.

MARTIN L. STEFFENS, Vice-Chair.
Oklahoma Natural Gas Co.
Box 1620
Oklahoma City, Okla.

BRUCE D. OWEN, Sec.-Treas.
Southwestern Bell Tel. Co.
405 N. Broadway
Oklahoma City, Okla.

• Corpus Christi Section

JOHN W. NEE, Chair.
c/o Briner Paint Mfg. Co., Inc.
3713 Agnes St.
Corpus Christi, Texas

CHARLES F. WARD, Vice-Chair.
Magnolia Petroleum Co.
Refining Dept.
Box 1179
Corpus Christi, Texas

JOHN P. WESTERVELT, Sec.-Treas.
Pontiac Refining Co.
P. O Box 1581
Corpus Christi, Texas

• Houston Section

L. G. SHARPE, Chairman
Humble Pipe Line Co.
P. O. Drawer 2220
Houston 1, Texas

J. A. CALDWELL, Vice-Chair.
Humble Oil and Ref. Co.
Box 2180
Houston, Texas

R. C. BOOTH, Sec.-Treas.
5719 South Seas
Houston, Texas

• New Orleans-Baton Rouge Section

JACK T. MARTIN, Chairman
The Texas Company
Production Dept.
P. O. Box 252
New Orleans, La.

FRANK S. BIRD, Vice-Chair.
The California Co.
800 The California Co. Bldg.
1111 Tulane Ave.
New Orleans, La.

RUSSELL W. SCHUTT, Sec.-Treas.
Shell Oil Company
P. O. Box 193
New Orleans, La.

• North Texas Section

J. C. SPALDING, JR., Chair.
Sun Oil Company
Box 2880
Dallas, Texas

MORRIS BOCK, Vice-Chair.
Sun Oil Company
1405 North Zangs Blvd.
Dallas, Texas

MARYANN DUGGAN, Sec.-Treas.
Magnolia Petroleum Co.
Box 900
Dallas, Texas

• Permian Basin Section

THOMAS M. NEWELL, Chairman
Cardinal Chemical, Inc.
Box 2049
Odessa, Texas

E. O. KEMPER, 1st Vice-Chair.
Permian Enterprises, Inc.
1010 N. Washington
Odessa, Texas

WILLIAM A. HOPWOOD,
2nd Vice-Chair.
Tnemec Co., Inc.
2703 S. Colonial Drive
Odessa, Texas

JOHN A. KNOX, Sec.-Treas.
The Western Co.
Box 310
Midland, Texas

• Sabine-Neches Section

CHRISTOPHER A. MURRAY, Chair.
Pure Oil Company
Box 237
Nederland, Texas

CHARLES A. RIDENOUR,
Vice-Chair.
Magnolia Petroleum Co.
P. O. Box 3311
Beaumont, Texas

V. M. BROWN, Sec.-Treas.
627½ Cleveland
Lake Charles, La.

• Shreveport Section

M. J. OLIVE, Chairman
Arkansas Natural Gas Corp.
Shreveport 4, La.

W. F. LEVERT, Vice-Chairman
United Gas Pipe Line Co.
P. O. Box 1407
Shreveport, La.

R. C. JORDAN, Secretary
United Gas Pipe Line Co.
Box 1407
Shreveport, La.

J. O. GRIFFIN, Treasurer
Texas Eastern Gas Trans. Corp.
Texas Eastern Bldg.
Shreveport, La.

• Teche Section

GEORGE M. HARPER, Chairman
Union Oil Co. of California
Box 421
Abbeville, Louisiana

GUS VOGLER, Vice-Chair.
Allen Cathodic Protection Co.
P. O. Box 264
Lafayette, La.

J. H. WATERFIELD, Sec.-Treas.
United Gas Corp.
New Iberia, La.

• Tulsa Section

JACK P. BARRETT, Chairman
Stanolind Oil & Gas Co.
P. O. Box 591
Tulsa, Oklahoma

LLOYD NELSON, Vice-Chair.
Shell Pipe Line Co.
1123 E. Second
Cushing, Oklahoma

HUGH A. BRADY, Secretary
Pipe Line Anode Corp.
P. O. Box 996
Tulsa, Oklahoma

EDWARD A. BARTOLINA, Treasurer
Moorlane Company
P. O. Box 1679
Tulsa, Oklahoma

WESTERN REGION

L. L. WHITENECK, Director
Long Beach Harbor Dept.
1333 El Embarcadero
Long Beach 2, Calif.

E. H. GRIZZARD, Chairman
Signal Oil & Gas Co.
811 West 7th St.
Los Angeles, Cal.

AUSTIN S. JOY, Vice-Chairman
Bechtel Corp., Somastic Div.
Box 457
Wilmington, Cal.

ROBERT H. KERR, Sec.-Treas.
Southern California Gas Co.
Box 3249 Terminal Annex
Los Angeles, Cal.

• Los Angeles Section

S. J. ARTESE, Chairman
Shell Oil Co., Inc.
Box 728
Wilmington, California

S. K. GALLY, Vice-Chairman
1061 Mar Vista Ave.
Pasadena, California

E. H. TANDY, Sec.-Treas.
Standard Oil Co. of Calif.
Box 97
El Segundo, California

• Salt Lake Section

HARRY R. BROUGH, Chairman
Mountain Fuel Supply Co.
36 South State St.
Salt Lake City, Utah

GEORGE R. HILL, Vice-Chair.
Fuel Technology Dept.
University of Utah
Salt Lake City, Utah

JOHN W. COX, Sec.-Treas.
Utah Oil Refining Co.
P. O. Box 898
Salt Lake City 10, Utah

• San Diego Section

L. E. MAGOFFIN, Chairman
California Water & Telephone Co.
19 West 9th St.
National City, Calif.

D. P. ARMBRUSTER, Vice-Chairman
San Diego Gas & Electric Co.
4206 Overlook Drive
San Diego, Calif.

DALLAS G. RAASCH, Sec-Treas.
La Mesa, Lemon Grove,
Spring Valley Irrigation District,
Box 518, La Mesa, Calif.

• San Francisco Bay Area Section

G. A. WORKS, JR., Chairman
Union Oil Co. of Cal.
Oleum, Cal.

D. R. LOPER, Vice-Chair.
Standard Oil Co. of Cal.
225 Bush St.
San Francisco, Cal.

T. J. SMITH, Sec.-Treas.
Electric Steel Foundry Co.
249 First St.
San Francisco 5, Cal.

CANADIAN REGION

G. I. RUSSELL, Chairman
Trans Mountain Pipeline Co.
1070 Hornby St.
Vancouver, B. C.

L. W. SHEMILT, Vice-Chair.
University of British Columbia
Vancouver, B. C.

G. M. McPHERSON, Sec.-Treas.
300 Ninth Ave. W.
Imperial Oil Ltd.
Calgary, Alta.

• British Columbia Section

F. FORWARD, Chairman
Dept. Mining & Metallurgy
U. of British Columbia
Vancouver, B. C.

F. M. CAZALET, Vice-Chair.
British Columbia Electric Railway
Vancouver, B. C.

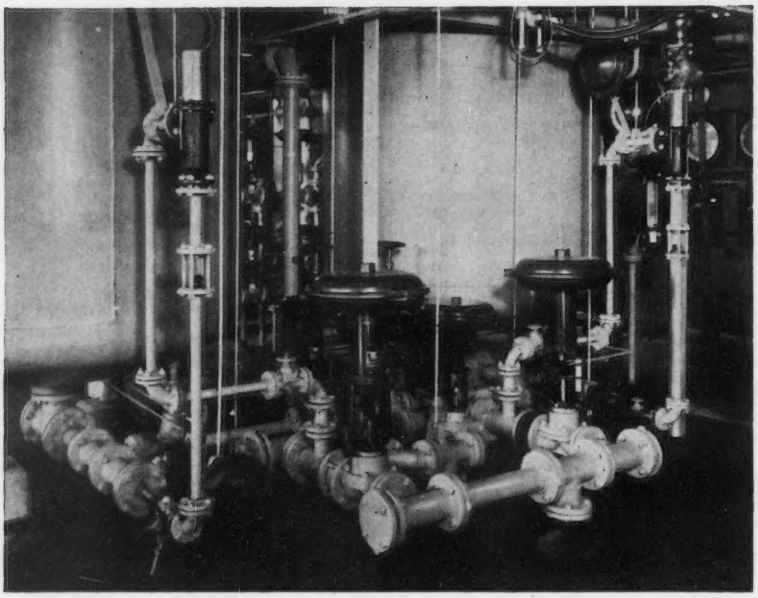
B. H. LEVELTON, Sec.-Treas.
British Columbia Research Council
University of British Columbia
Vancouver, B. C.

(Continued on Page vi)

DOW

CORROSIVE LIQUIDS CAN'T HURT THIS INSTALLATION

Large midwest corn processor installs SARAN lined pipe, fittings and valves



When one of the largest processors of corn in the midwest was faced with the problem of handling corrosive liquid safely and efficiently in an ion exchange system, they investigated saran lined pipe and fittings.

They learned that saran lined pipe fittings and valves assure tight, leakproof joints. They were convinced that the excellent corrosion resistance of strong, rigid saran lined pipe would mean longer service and greater dependability. The sum total of advantages offered by saran lined pipe indicated that it would meet the company's demands for equipment that would assure uninterrupted processing free from the expense and inconvenience of unscheduled "shutdowns." Wherever piping with unusual resistance to most chemicals and solvents is involved, install saran lined steel pipe. It can be easily cut and threaded in the field without need for special tools or handling; costly downtime can be reduced to a minimum. We'll be glad to assist you with installation plans. Write or call the Saran Lined Pipe Company, Ferndale, Michigan. Offices in New York • Boston • Pittsburgh Tulsa • Philadelphia • Chicago • Portland • Indianapolis • San Francisco Houston • Denver • Los Angeles • Seattle Cleveland • Charleston, S. C. • Toronto Montreal. Saran lined pipe is a product of THE DOW CHEMICAL COMPANY.

Saran Lined Pipe Company
2415 Burdette Ave., Ferndale, Mich.

Please send me a copy of your catalog on Saran Lined Pipe, Valves and Fittings.

Name_____

Title_____

Company_____

Address_____

City_____ State_____

RELATED SARAN PRODUCTS
Saran rubber tank lining • Saran rubber molding stock • Saran pipe and fittings Saran tubing and fittings

you can depend on DOW PLASTICS DOW

Directory of Officers

(Continued from Page v)

• Hamilton-Niagara Section

(Temporary Officers)

C. E. MAKEPEACE, Chairman
Page Hersey Tubes Ltd.
Welland Ontario, Canada

H. W. HYSLOP, Vice-Chairman
United Gas & Fuel Co. of Hamilton, Ltd.
82 King St. E.
Hamilton, Ontario, Canada

R. J. BERKOL, Sec.-Treas.
Atlas Steels, Ltd.
Welland, Ontario, Canada

• Toronto Section

T. R. B. WATSON, Chairman
Corrosion Service, Ltd.
21 King St. E.
Toronto, Ontario, Canada

COLIN PRESCOTT, Vice-Chair.
Hydro-Electric Power Commission of Ontario
620 University Ave.
Toronto, Ontario, Canada

R. J. LAW, Secretary
The International Nickel Co. of Canada, Ltd.
25 King St. W.
Toronto, Ontario, Canada

STEPHEN KOZAK, Treasurer
Canada Wire & Cable Co., Ltd.
Postal Station R.
Toronto, Ontario, Canada

Lapel Pins

Approx. Size

Approximately 7/16 inches high, gold, inlaid with bright red enamel background to "NACE" and deep blue enamel background to words "CORROSION CONTROL." Ruby center.

•

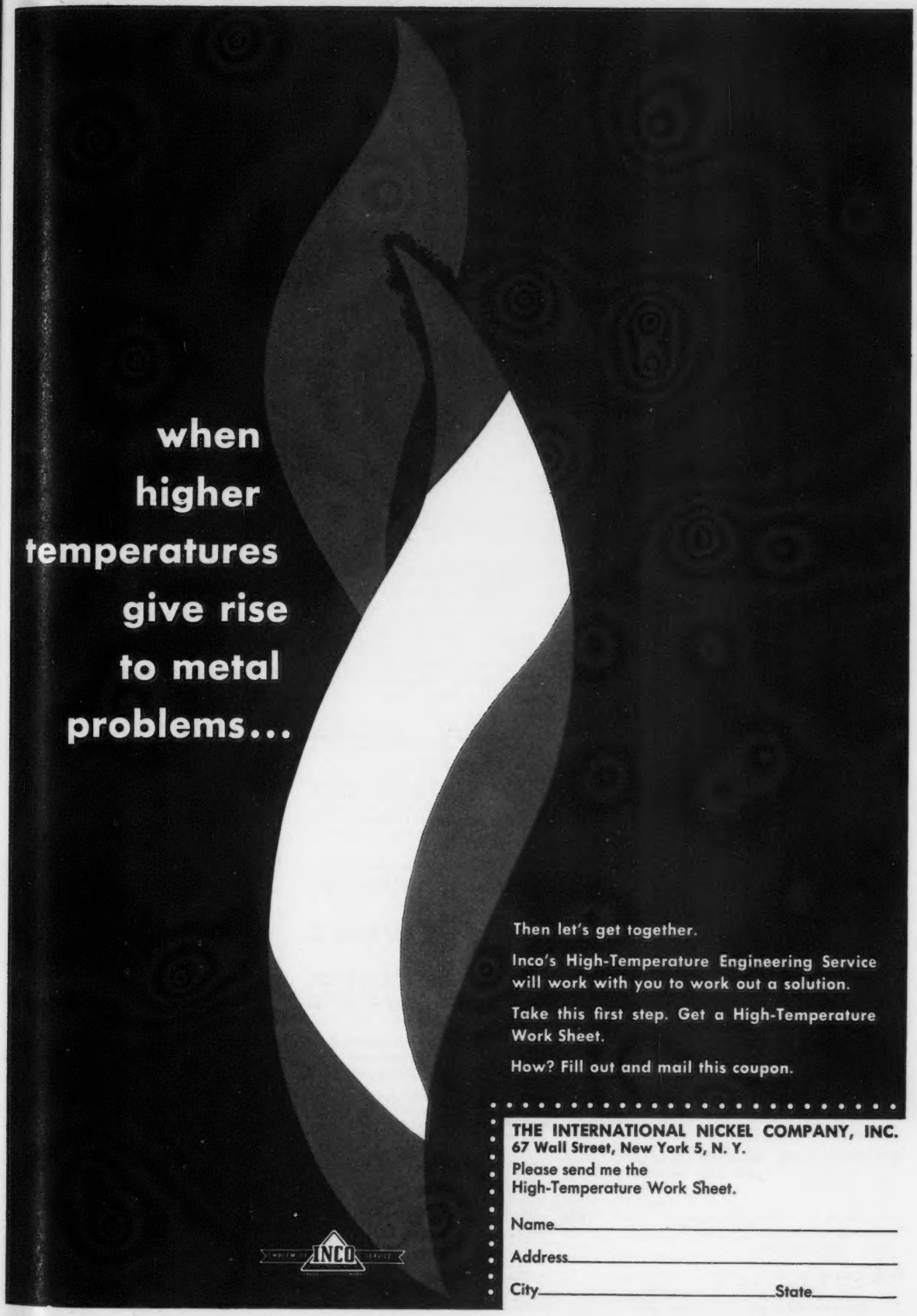
For Association Members Only

$7

Address Orders to
A. B. Campbell, Executive Secretary

NATIONAL ASSOCIATION OF CORROSION ENGINEERS

1061 M & M Bldg., Houston 2, Texas


when
higher
temperatures
give rise
to metal
problems...
Then let's get together.
Inco's High-Temperature Engineering Service will work with you to work out a solution.
Take this first step. Get a High-Temperature Work Sheet.
How? Fill out and mail this coupon.
THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street, New York 5, N. Y.
Please send me the
High-Temperature Work Sheet.
Name
Address
City
State
INCO

DIRECTORY OF TECHNICAL PRACTICES COMMITTEES

H. W. SCHMIDT, Chairman
Dow Chemical Company
Midland, Michigan

EX-OFFICIO MEMBERS

WALTER F. ROGERS
AARON WACHTER
A. B. CAMPBELL

(Chairmen of all numbered committees listed below are members of the full committee)

TP-1 CORROSION OF OIL AND GAS WELL EQUIPMENT (Formerly Condensate Well Corrosion)

R. C. BUCHAN, Chairman
Humble Oil & Ref. Co.
Box 2180
Houston, Texas

E. C. GRECO, Vice-Chairman
United Gas Corp.,
Box 1407
Shreveport, La.

TP-1A Pacific Coast. J. J. Browne, vice-chairman; General Petroleum Corp., Box 726, Wilmington, Cal.

TP-1B Condensate Well Corrosion. R. C. Buchan, Chairman. Humble Oil & Refining Co., Houston, Texas.

TP-1C Sweet Oil Well Corrosion. H. L. Bilhartz, chairman; H. E. Greenwell, vice-chairman, both with Atlantic Refining Co., P. O. Box 2819, Dallas.

TP-1D Sour Oil Well Corrosion. Co-chairmen: J. A. Caldwell, Humble Oil & Ref. Co., Box 2180, Houston, Texas, and R. L. Elkins, Shell Oil Corp., Box 1509, Midland, Texas.

TP-1F Metallurgy—Oil and Gas Well Equipment. F. A. Prange, chairman; Phillips Petroleum Co., Bartlesville, Okla.

TP-1G Sulfide Stress Corrosion. R. S. Treseder, Shell Development Co., Emeryville, Cal.

TP-1H Corrosion of Oil String Casing. Jack L. Battle, Humble Oil & Ref. Co., Box 2180, Houston, Texas

TP-1J Oil Field Structural Plastics. W. M. Thornton, Atlantic Refining Co., P. O. Box 2819, Dallas, Texas; B. W. Bradley, Shell Oil Company, Tulsa, Okla., co-chairmen.

TP-2 GALVANIC ANODES FOR CATHODIC PROTECTION

H. A. ROBINSON, Chairman
The Dow Chemical Co.
616 East Grove St.
Midland, Mich.

H. W. WAHLQUIST, Vice-Chairman
Ebasco Services
2 Rector St.
New York, N. Y.

TP-2A Correlation of Data From Operating Installations. L. R. Sheppard, Shell Pipe Line Corp., Houston, Texas.

TP-3 ANODES FOR USE WITH IMPRESSED CURRENTS

A. W. PEABODY, Vice-Chairman
Ebasco Services
2 Rector St.
New York, N. Y.

TP-4 MINIMUM CURRENT REQUIREMENTS FOR CATHODIC PROTECTION

L. P. SUDRABIN, Chairman
Electro Rust-Proofing Corp.
No. 1 Main St.,
Belleville, N. J.

TP-5 CORROSION PROBLEMS INVOLVED IN PROCESSING AND HANDLING CHEMICALS

PAUL J. GEGNER, Chairman
Columbia-Southern Chemical Corp.
Barberton, Ohio

TP5A Corrosion by Sulfuric Acid. C. L. Bulow, chairman; Bridgeport Brass Co. 30 Grand St., Bridgeport, Conn. W. A. Luce, vice-chairman; The Duriron Co., Box 1019, Dayton, Ohio

TP-5C Sub-Surface Corrosion by Alkaline Solutions (Caustic Embrittlement). C. F. Pogacar, chairman; Atlantic Refining Co., 260 South Broad St., Philadelphia, Pa.

TP-5D Corrosion by Organic Acids and Bases. H. O. Teeple, chairman, International Nickel Co., Inc., 67 Wall St., New York City.

TP-5F Corrosion by Chlorine. R. I. Zimmerer, chairman; Westvaco Chemical Division, Food Machinery & Chemical Corp., Drawer 8127, Charleston 3, West Virginia.

TP-5G Corrosion by Nitric Acid. J. L. English, chairman; Oak Ridge National Laboratory, P. O. Box P, Oak Ridge, Tenn.

TP-6 PROTECTIVE COATINGS

A. J. LIEBMAN, Chairman
Dravo Corporation
Dravo Building
Pittsburgh, Pa.

PACIFIC (West Coast Div.)
L. L. Whiteneck, Chairman
Long Beach Harbor Dept.
Long Beach 7, Cal.

TP-6A Organic Coatings and Linings for Resistance to Chemical Corrosion. Kenneth Tator, Chairman.

TP-6B Protective Coatings for Resistance to Atmospheric Corrosion. L. L. Sline, Sline Industriol Painters, 2612 Terminal Drive, Houston, and Howard C. Dick, Products Research Service, Inc., Box 6116, New Orleans, La., co-chairmen.

TP-6C Protective Coatings for Resistance to Marine Corrosion. Raymond P. Devoluy, Chairman. C. A. Woolsey Paint & Color Co., 229 E. 42nd St., New York 17, N. Y.

TP-6E Protective Coatings in Petroleum Production. Jack P. Barrett, Stanolind Oil and Gas Company, Tulsa, Okla.

TP-6G Surface Preparation for Organic Coatings. A. J. Liebman, chairman; Dravo Corp., Dravo Bldg., Pittsburgh 22, Pa. L. R. Whiting, Bakelite Corp., 30 East 42nd St., New York 17, N. Y.

TP-6H Glass Linings and Vitreous Enamel. G. H. McIntyre, Chairman. Ferro-Enamel Corp., Harvard & 56th St., Cleveland 5, Ohio.

TP-6K Corrosion Resistant Construction with Masonry and Allied Materials. Robert R. Pierce, Chairman. Pennsylvania Salt Manufacturing Co., 1000 Widener Bldg., Philadelphia, Pa.

TP-6L Asphalt Type Underground Protective Coatings. R. J. Schmidt, California Research Corp., 200 Bush St., San Francisco, Cal., chairman.

TP-7 MATERIALS FOR USE AT HIGH TEMPERATURES

M. A. SCHEIL, Chairman
Director Metallurgical Research
A. O. Smith, Corporation
Milwaukee, Wisconsin

TP-8 CORROSION BY WATERS

V. V. KENDALL, Chairman
National Tube Division
United States Steel Corp.
Frick Bldg.,
Pittsburgh 30, Pa.

TP-8A Corrosion by Gulf Coast Cooling Waters. Charles P. Dillon, chairman, Carbide and Carbon Chemicals Co., Texas City, Texas. W. B. Brooke, vice-chairman, Dow Chemical Company, Freeport, Texas.

TP-9 CORROSION INHIBITORS

ROBERT S. WISE, Chairman
National Aluminate Corp.
6216 West 66th Place
Chicago, Ill.

J. L. WASCO, Vice-Chair.
The Dow Chemical Co.
Midland, Mich.

TP-11 IDENTIFICATION OF CORROSION PRODUCTS

C. E. IMHOFF, Chairman
Research Supervisor, Chemical Lab.
Allis-Chalmers Mfg. Co.
Milwaukee 1, Wis.

TP-12 EFFECT OF ELECTRICAL GROUNDING ON CORROSION

GLEN APPLEMAN, Chairman
Pennsylvania Power & Light
Ninth & Hamilton St.
Allentown, Pa.

TP-13 ANNUAL LOSSES DUE TO CORROSION

F. N. ALQUIST, Chairman
The Dow Chemical Co.
Midland, Michigan

TP-14 INSTRUMENTS FOR CORROSION MEASUREMENTS

H. N. HAYWARD, Chairman
Engineering Experiment Station
University of Illinois
Urbana, Ill.

TP-15 CORROSION CONTROL IN THE TRANSPORTATION INDUSTRIES

K. K. KESSLER, Chairman
Baltimore & Ohio Railroad
Baltimore 23, Maryland

G. M. MAGEE, Vice Chair.
Assoc. Amer. Railroads
Technology Center
Chicago 16, Ill.

TP-16 ELECTROLYSIS AND CORROSION OF CABLE SHEATHS

IRWIN C. DIETZE, Chairman.
Dept. of Water & Power,
City of Los Angeles, Cal.

TP-16A Stray Railway Current Electrolysis. M. D. Fletcher, Chairman, Illinois Bell Telephone Co., 212 West Randolph St., Chicago 6, Ill. J. Svetlik, Co-chairman, Northern Indiana Public Service Co., 5265 Hohman Ave., Hammond, Ind.

TP-16B T. J. Maitland, Chairman, American Telephone and Telegraph Co., 32 Sixth Ave., New York 13, N. Y.

TP-16C Cathodic Protection of Cable Sheaths. R. M. Lawall, chairman, American Telephone & Telegraph Co., 1538 Union Commerce Bldg., Cleveland 14, Ohio. W. J. Schreiner, co-chairman, Cincinnati Gas & Electric Co., Cincinnati 2, Ohio.

TECHNICAL PRACTICES COMMITTEES' DIRECTORY

(Continued from Page viii)

TP-16D *Tests and Surveys. Frank E. Kulman, Co-chairman, Consolidated Edison Co. of New York, 4 Irving Place, New York 3, N. Y.*

TP-16E *Corrosion and Protection of Pipe-Type Cables. Frank Kahn, Chairman, Philadelphia Electric Co., 2301 Market St., Philadelphia 3, Pa.*

TP-16F *Nonmetallic Sheath Coatings. Geo. H. Hunt, Chairman, Simplex Wire & Cable Co., 79 Sidney St., Cambridge 39, Mass.*

TP-17 STANDARDIZATION OF PROCEDURES FOR MEASURING PIPE COATING CONDUCTANCE

W. E. HUDDLESTON, Chairman
Huddleston Engineering Co.
Bartlesville, Okla.

TP-18 INTERNAL CORROSION OF FACILITIES FOR STORAGE AND TRANSPORTATION OF PETROLEUM

L. G. SHARPE, Chairman
Humble Pipe Line Co.
Houston, Texas

TP-18A *Internal Sour Crude Corrosion of Pipe Lines and Tanks. R. L. Bullock, chairman; Interstate Oil Pipe Line Co., Box 1107, Shreveport, La. J. N. Hunter, Jr., vice-chairman; Service Pipe Line Co., Box 1979, Tulsa, Okla.*

TP-18B *Internal Corrosion of Products Pipe Lines. Ivy M. Parker, Plantation Pipe Line Co., Box 1743, Atlanta, Ga., chairman; Raymond Hadley, Sun Pipe Line Co., 1608 Walnut, Philadelphia 3, Pa., vice-chairman.*

TP-19 CORROSION BY DE-ICING SALTS

SPECIALISTS IN ALL
RESISTANT PIPING MATERIALS
TO YOUR SPECIFICATIONS

RM RESISTANT MATERIALS

TUBING

•

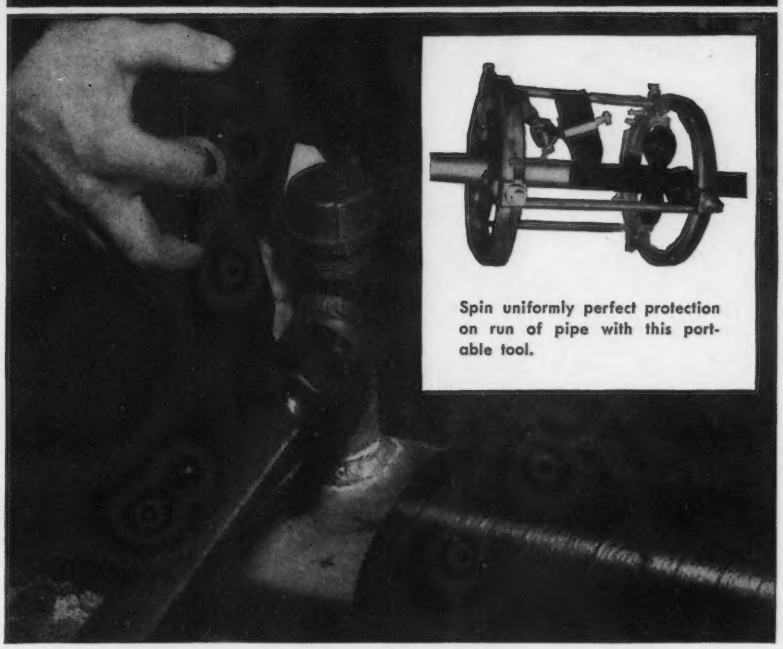
TYGON—TEFLON
SARAN—RUBBER
STAINLESS—ALUMINUM
MONEL—NICKEL

•

IMMEDIATE DELIVERY
Full Range of Sizes—Complete Stocks

RAY MILLER
254 NORTH 10th STREET, NEWARK 7, N. J.
4240 KANAWHA T'PK., SO. CHARLESTON, W. VA.
1210 HAYS STREET, HOUSTON, TEXAS

TRY DRESSERTAPE*



Spin uniformly perfect protection on run of pipe with this portable tool.

Fast, easy, effective
CORROSION PROTECTION!

No matter who does the job, *all* your underground pipe and joints can now have *full, permanent protection* against corrosion. Dressertape—the high dielectric plastic tape—is the answer. Any crew can master the easy application techniques in minutes, save expensive man hours and cut over-all costs on every job. Try Dressertape yourself!

LOOK AT THESE OUTSTANDING DRESSERTAPE ADVANTAGES!

- Uniform coating—top, bottom and sides.
- Easy, clean to apply—sticks at a touch, no heating equipment required.
- Safe to use—no burns, no fumes.
- Conforms to irregular surfaces—especially over fittings on service lines.
- Immediate backfill—no waiting.
- Exceptional electrical properties—dielectric strength: 10,000 volts; insulation resistance: 100,000 megohms.
- Lasting protection against water, oil and soil chemicals—equal to, or exceeding, yard or mill-wrapped pipe.
- Available in widths from ¾" to 6".

Send today for our new, fully illustrated booklet "Dresser Taping Fundamentals". Anyone can master Dresser's laboratory and field proved methods in minutes.

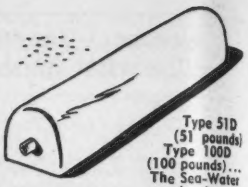
*Dressertape is a trade-mark of Dresser Manufacturing Division

DRESSER® MANUFACTURING DIVISION

59 Fisher Ave., Bradford, Pa.
(One of the Dresser Industries)
SALES OFFICES:
New York, Philadelphia, Chicago, Houston, S. San Francisco. In Canada:
629 Adelaide St., W., Toronto, Ont.

at CATHODIC PROTECTION SERVICE . . .

Type 9D (9 pounds)
Type 17D (17 pounds)
Type 32D (32 pounds)

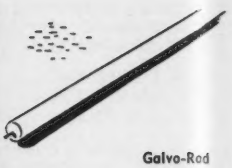


Type 51D (51 pounds)
Type 100D (100 pounds)...
The Sea-Water Anodes

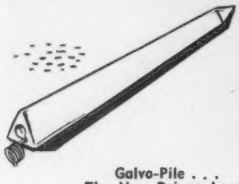
Type 50D (50 pounds)

Type 60DS . . .
The New Ship-Hull Anode

Types 9D, 17D, 32D
Galvo-Pack Units



Galvo-Rod



Galvo-Pile . . .
The New *Driven* Anode

Galvo-Line

DOW MAGNESIUM ANODES *Now Available*

CAST TO THE **HIGHEST** PURITY SPECIFICATIONS THE INDUSTRY HAS EVER KNOWN!

All magnesium anodes are now guaranteed to meet the following rigid purity specifications:

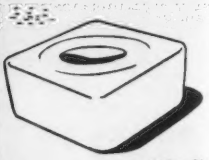
% Al	5.3-6.7	% Cu	0.02 max.
% Mn	0.15 min.	% Ni	0.002 max.
% Zn	2.5-3.5	% Fe	0.003 max.
% Si	0.10 max.	% Other imp.	0.03 max.

% Magnesium—Remainder

It will be noted that the maximum limits have been lowered for the two impurities, copper and nickel, which have proven themselves to be the worst offenders insofar as their effect on current efficiency is concerned—a fact substantiated by published data.

GOOD QUALITY MEANS GOOD ECONOMY

When backfill and installation costs are taken into account, calculation will show that an increase of only 1% in anode efficiency will result in an effective savings of 5% in purchase price of the bare anode.



Galvo-Slab

CPS

OTHER FIRST LINE MATERIALS INCLUDE:

Good-All Rectifiers
CPS Graphite Anodes
Polyken Protective Tape Coatings
Maloney Insulating Materials
Erico Cadweld Welding Materials
Fisher M-Scope Pipe and Cable Locators
Detectron Pipe Locators
Wahlquist Pipe Locators
CPS Graphite Anode Backfills
Homco and Barada and Page Backfills
Agra and Collins Meters
Associated Research Resistivity Meters
Rubicon Potentiometers
Pearson Holiday Detectors
Holloway Shunts
Direct-Burial Cable
Ditch-Witch Trenchers

cathodic protection service

OFFICES LOCATED IN

HOUSTON
4601 Stanford Street
Houston 6, Texas
Phone JA-5171

TULSA
314 Thompson Building
Tulsa, Okla.
Phone 2-9857

NEW ORLEANS
1639 Robert Street
New Orleans 15, La.
Phone CH-8310

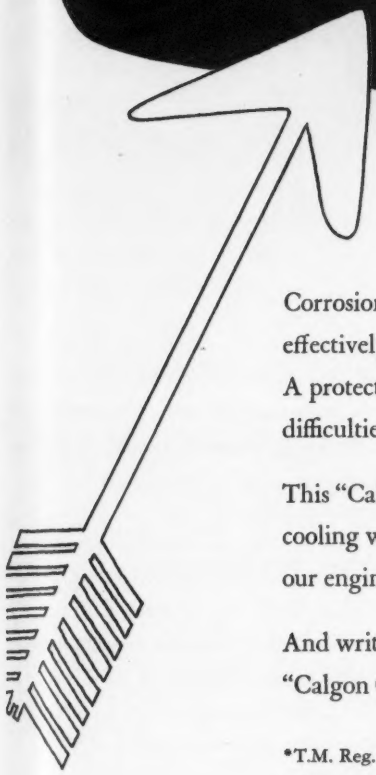
Everything in the cathodic protection field . . . from an insulating washer to a turnkey contract installation.

Control Corrosion

in cooling water systems with

Calgon*

THRESHOLD TREATMENT



Corrosion in water systems is efficiently and effectively controlled by Calgon Threshold Treatment. A protective film forms on metallic surfaces, ending corrosion difficulties in pipes, tubes, on heat transfer surfaces.

This "Calgon film" protects all types of industrial cooling water systems. If you will tell us about your problems, our engineers will be glad to show you what Calgon can do.

And write for your free copy of our booklet "Calgon Controls Corrosion."

*T.M. Reg. U.S. Pat. Off.

**Calgon Threshold Treatment for controlling corrosion licensed under U.S. Patent 2,337,856

HAGAN HALL BUROMIN CALGON

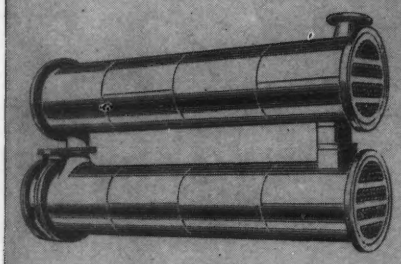
calgon, inc.

A SUBSIDIARY OF HAGAN CORPORATION
HAGAN BUILDING
PITTSBURGH 30, PA.

HAYNES Alloy Tubing

Trade-Mark

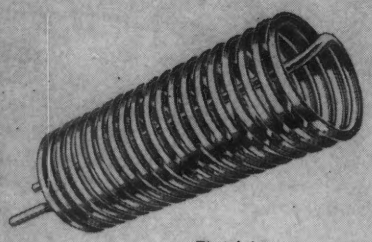
FOR SEVERE SERVICE CONDITIONS



Heat Exchangers

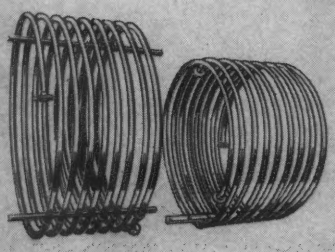
Tubing made of HAYNES alloys gives long, uninterrupted service under severe conditions of heat, corrosion, or oxidation. The tubing can be obtained in four different alloys, each having a particular combination of unusual properties to combat certain service conditions. The chart below shows some of the media these alloys resist. Typical applications are heat exchangers, coils, calandrias, and fluid lines.

All four HAYNES alloys are supplied in welded or welded and cold drawn tubing. Most common welding methods—including metallic-arc and HELIARC welding—can be used in fabricating the tubing installations. If you wish further information about HAYNES alloy tubing, contact the nearest Haynes Stellite Company district office.



Fluid Lines

USE TUBING OF	FOR RESISTANCE TO
HASTELLOY Alloy B (nickel-molybdenum-iron)	Hydrochloric acid, wet hydrogen chloride gas, sulphuric acid, phosphoric acid, organic acids, high temperatures.
HASTELLOY Alloy C (nickel-molybdenum-chromium-iron)	Nitric acid, free chlorine, acid salts, hydrochloric acid, sulphuric acid, phosphoric acid, organic acids, sulphurous acid, high temperatures.
MULTIMET Alloy (cobalt-chromium-nickel-iron)	Oxidation, high temperatures.
HAYNES Alloy No. 25 (cobalt-chromium-tungsten-nickel)	Oxidation, high temperatures, carburization, wet chlorine, nitric acid.



Coils

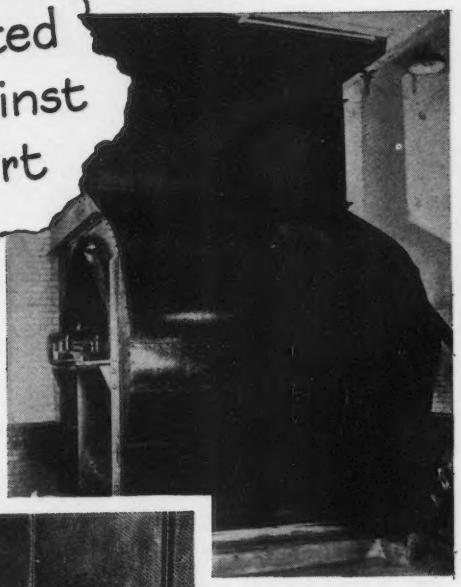
HAYNES TRADE-MARK *alloys*

"Haynes," "Hastelloy," "Heliarc," and "Multimet" are trade-marks of Union Carbide and Carbon Corporation.

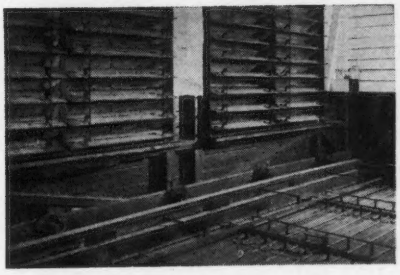
Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
UCC
General Offices and Works, Kokomo, Indiana
Sales Offices
Chicago — Cleveland — Detroit — Houston
Los Angeles — New York — San Francisco — Tulsa

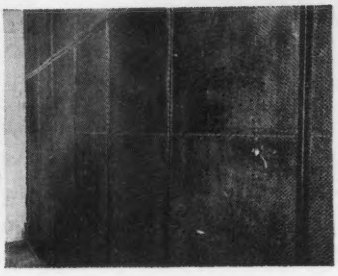
Parlon Stays On!

"...Parlon paint has protected our air conditioning against moisture, grease and dirt for over 10 years"



Below: Louver system of air-washing unit at Judson Mills and baffles in front of electric filter, which cleans air, are located in blending room. Both are given longer life with a protective coating of Rubalt RA paint based on Parlon. Here, this sturdy finish must withstand constant humidities of 96% at 51° F. In addition to excellent protection against corrosion, Parlon finishes resist mold and algae growth stimulated by the presence of yarn size in the atmosphere.





Giant fan units at Judson Mills, like that above, are now painted prior to installation, and at 18-month intervals, with Rubalt RA paint based on Parlon. This system protected oldest fan, still in steady operation, for more than 10 years against all effects from corrosion.

In all air conditioning equipment, moisture poses a constant problem. In textile mills, add the grease, dirt, and other corrosive elements picked up in the system and it is easy to understand why parts rust out and need replacement after only a few years of use. Most paints, even though applied frequently, provide inadequate protection.

At Judson Mills, Greenville, S. C., where paint based on Hercules Parlon (chlorinated rubber) has been applied every 18 months, equipment remains in good operating condition 10 years after installation! Metal parts are still in excellent shape. Moreover, Parlon does not flake off and escape into the circulating system and contaminate valuable fabrics being loomed in the factory. For this reason, Judson now paints all of its new equipment with Parlon before installation.

Wherever corrosion is a problem, Parlon gives better service at lower long-term costs. See your paint supplier for details, or write:

Cellulose Products Dept., HERCULES POWDER COMPANY 999 King St., Wilmington 99, Del.

INCORPORATED

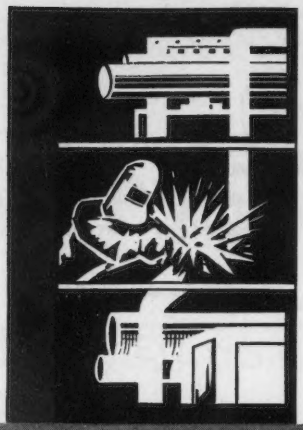
Parlon® CHLORINATED RUBBER PAINTS

AVAILABLE FROM 400 PAINT MANUFACTURERS UNDER THEIR OWN BRAND NAMES

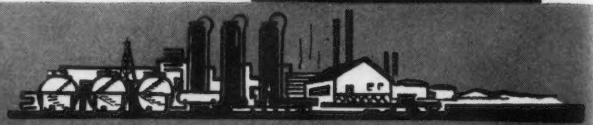
CHEAPER THAN METALS

SIMPLER THAN WELDING

SURER THAN ALLOYS



KONTOL

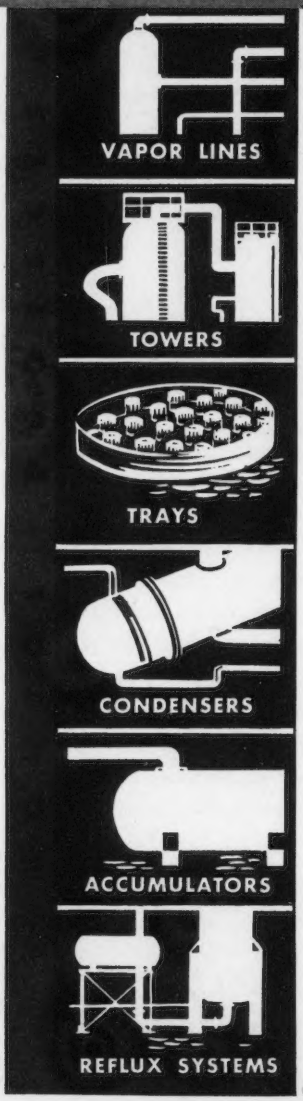


REFINERY CORROSION PROTECTION

The cost of Kontol corrosion protection, when compared with the costly metals it protects, is negligible. In addition to its protection against corrosion, the detergent properties of Kontol promotes cleaner operating units. With clean equipment, the gains in operating efficiencies accruing from efficient heat exchange and smooth flow are a considerable economic factor.

Kontol is easily injected into a refinery system — all that is required is a conventional chemical pump and small reservoir for the chemical. Compare the cost of Kontol protection with the cost of shutting a unit down, cutting corroded equipment out, welding replacements in!

While the use of alloys will aid in the combatting of corrosion, in very few instances are they a cure-all. Kontol is effective in protecting metals against attack by organic and inorganic acids, brines, hydrogen blistering and hydrogen embrittlement. It adsorbs readily to steel, nickel and stainless alloys of steel, brass, admiralty and monel.



For complete information, call or write to

TRETOLITE COMPANY

Chemicals and services for the petroleum industry

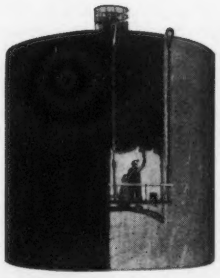
SAINT LOUIS 19, MISSOURI • LOS ANGELES 22, CALIFORNIA

DEHYDRATING • DESALTING • CORROSION INHIBITING • SCALE PREVENTING

PARAFFIN REMOVING • WATER DE-OILING

KR B 53-3

"Who said people don't like Black?"



Pitt Chem coatings withstand years of exposure to a wide variety of atmospheric and chemical conditions.

LET'S TALK SENSE about the color of protective coatings. Pitt Chem Tar Base Coatings, for example, are as black as the ace of spades. Our service engineers would never recommend them for the walls of your office. But—for the protection of equipment and structures against corrosion, we think their color is the most practical one you could select. And a recent survey shows that plant people agree with us. They select black as one of the two most popular of all industrial coating colors. Why?

It doesn't fade. It "goes" with all other colors.

It doesn't require cleaning. It creates no glare.

And remember this: The black color of Pitt Chem Tar Base Coatings tells you they're made of one of the most impervious and durable of all protective materials—coal tar pitch. For long-lasting, economical protection against most mineral acids, alkalis, corrosive vapors and moisture, there's no finer protective material on the market today. ● If you have a corrosion problem write or call a Pitt Chem Coating Specialist today. He'll gladly make recommendations . . . without cost or obligation.

PITT CHEM 101
For severest corrosive conditions

PITT CHEM 102
A thin, high gloss maintenance coating

PITT CHEM 103
For metal exposed to vapors, dilute acids and alkalis

PITT CHEM 104
For equipment handling potable water

AND OTHER SPECIALTY COATINGS

W&D 4555 D

PROTECTIVE COATINGS DIVISION

PITTSBURGH
COKE & CHEMICAL CO.

Grant Building · Pittsburgh 19, Pa.

COAL CHEMICALS • AGRICULTURAL CHEMICALS • FINE CHEMICALS • PROTECTIVE COATINGS • PLASTICIZERS • ACTIVATED CARBON • COKE • CEMENT • PIG IRON

THE NATIONAL ASSOCIATION OF CORROSION ENGINEERS

is a non-profit, scientific and research association of individuals and companies concerned with corrosion or interested in it, whose objects are:

(a) To promote the prevention of corrosion, thereby curtailing economic waste and conserving natural resources.

(b) To provide forums and media through which experiences with corrosion and its prevention may be reported, discussed and published for the common good.

(c) To encourage special study and research to determine the fundamental causes of corrosion, and to develop new or improved techniques for its prevention.

(d) To correlate study and research on corrosion problems among technical associations to reduce duplication and increase efficiency.

(e) To promote standardization of terminology, techniques, equipment and design in corrosion control.

(f) To contribute to industrial and public safety by promoting the prevention of corrosion as a cause of accidents.

(g) To foster cooperation between individual operators of metallic plant and structures in the joint solution of common corrosion problems.

(h) To invite a wide diversity of membership, thereby insuring reciprocal benefits between industries and governmental groups as well as between individuals and corporations.

It is an incorporated association without capital stock, chartered under the laws of Texas. Its affairs are governed by a Board of Directors, elected by the general membership. Officers and elected directors are nominated by a nominating committee in accordance with the articles of organization. Election is by the membership.

Inquiries regarding membership, and all general correspondence should be directed to the Executive Secretary at the administrative headquarters of the National Association of Corrosion Engineers at 1061 M & M Building, No. 1 Main Street, Houston 2, Texas.

Officers, 1953-54

President.....WALTER F. ROGERS
Houston, Texas

Vice-President.....AARON J. WACHTER
Emeryville, Cal.

Treasurer.....R. A. BRANNON
Houston, Texas

Executive Secretary.....A. B. CAMPBELL
1061 M & M Building, Houston 2, Texas

Directors

President

WALTER F. ROGERS.....1953-54
Gulf Oil Corporation, Houston

Vice-President

AARON WACHTER.....1953-54
Shell Development Company, Emeryville, Cal.

Treasurer

R. A. BRANNON.....1953-54
Humble Pipe Line Company, Houston

Past President

M. G. FONTANA.....1953-54
Ohio State University, Columbus

Representing Active Membership

W. F. FAIR, JR.....1953-56
Koppers Co., Westfield, N. J.

ROBERT L. BULLOCK.....1953-56
Interstate Oil Pipe Line Co., Shreveport, La.

NORMAN HACKERMAN.....1952-55
University of Texas, Houston

L. A. HUGO.....1951-54
Phillips Petroleum Co., Bartlesville, Okla.

Representing Corporate Membership

J. PAT CASEY, JR.....1953-56
The Crane Company, Chicago, Ill.

H. P. GODARD.....1952-55
Aluminium Laboratories, Ltd., Kingston, Ont.

V. V. KENDALL.....1952-55
United States Steel Corp., Pittsburgh, Pa.

H. A. HUMBLE.....1951-54
Dow Chemical Corp., Midland, Mich.

C. P. LARRABEE.....1951-54
United States Steel Corp., Vandergrift, Pa.

Representing Regional Divisions

WALTER R. CAVANAGH..(North Central) 1953-56
Parker Rust Proof Company, Detroit, Mich.

DERK HOLSTEYN.....(South Central) 1953-56
Shell Oil Company, Houston, Texas

ROBERT J. LAW.....(Canadian)
International Nickel Co. of Canada, Ltd., Toronto

L. L. WHITENECK.....(Western) 1952-55
Board of Harbor Commissioners, Long Beach, California

E. D. McCAULEY.....(South East) 1952-54
American Cast Iron Pipe Co., Birmingham, Ala.

L. B. DONOVAN.....(North East) 1951-54
Consolidated Edison Co. of N. Y., New York City

Directors Ex Officio

L. A. BALDWIN, Chairman Regional Management Committee
Johns-Manville Sales Corp., New York, N. Y.

E. P. NOPPEL, Chairman Policy and Planning Committee
Ebasco Services, Inc., New York, N. Y.

R. B. HOXENG, Chairman Publication Committee
United States Steel Corp., Pittsburgh, Pa.

H. W. SCHMIDT, Chairman Technical Practices Committee
The Dow Chemical Company, Midland, Mich.

Corrosion

OFFICIAL MONTHLY PUBLICATION

National Association of Corrosion Engineers

An Association of Individuals and Organizations Concerned with Control of Corrosion

1061 M & M Building Houston 2, Texas

Vol. 9 June, 1953 No. 6

Responses of 1953 NACE Award Recipients

FRANK NEWMAN SPELLER AWARD

By SCOTT P. EWING

Mr. Chairman, Officers of the NACE, Members, and Guests: As you know, your President has asked that I make a speech. He has also imposed some restrictions on what I should say—it has to be short, it has to be clean, it cannot be technical, no title was suggested and it ought to be good. These restrictions do not bother me in the least and I consider it a great privilege to say a few words to this group that includes many of my best friends.

My activities in corrosion work have been similar to those of many of you. Most of the time I have been employed by organizations that own or operate large metallic structures that are considered important. So I have been closely associated with engineers whose responsibility is to design or operate these structures so that they will serve their intended purpose and so that they will continue to do this for a long time with a minimum of maintenance cost. In many cases it was not certain how this could best be accomplished but it always seemed possible to find someone who either knew the answer or was sure that no answer existed. You see there has not always been an NACE but there has always been a need for it, as far back as I can remember.

This assistance, advice and good judgment was obtained in many ways. In some cases it was merely an informal conversation. The Corrosion Committee of the American Gas Association sponsored and guided my activities at the National Bureau of Standards over a period of many years. During this time, many especially qualified people were asked to review various reports and papers, and this always resulted in improvement. The unusual and unique problems involved in protecting the structures in the Panama Canal, on which Dr. Speller served as consultant, also required help from many individuals and organizations. During the last war much of the corrosion research of the Bureau of Ships was organized and coordinated by various groups who were familiar with the available facilities and qualified personnel for studying these problems.

Practically all of these people who have thus been concerned with my activities are now prominent in the affairs of this association. So it seems to me that it would be more appropriate to pass this award in the opposite direction if such a thing were possible.

All of you know that there are many highly capable corrosion engineers in this association who have important responsibilities and who have taken an active part in the affairs of the association, and who have received no recognition for their abilities or efforts. I personally feel that I have always been fortunate in having employers who permitted me to do about as I pleased and I have had a lot of fun. So I accept this award with considerable modesty and I wish to sincerely thank you Mr. Berry, President Fontana, the Awards Committee and the directors of the association for this very high honor.

WILLIS RODNEY WHITNEY AWARD

By ROBERT M. BURNS

It is a high honor and a particular satisfaction to receive the Whitney Award commemorating as it does the application of scientific thinking to the reactions of metallic corrosion. In his classic paper published just fifty years ago this coming month. Whitney concluded that "the electrochemical relationship between iron and hydrogen is the primal cause of rusting." The theoretical deductions which led to this simple but fundamental statement were followed by a description of supporting experiments. Other chemists in later years have by further elaboration contributed much to our understanding of corrosion processes and our methods of corrosion control.

Enough has been accomplished in corrosion studies so that pursuit of the subject offers satisfactions both to the practical and to the theoretical minded. The latter, interested primarily in the discovery of new knowledge, should be encouraged to choose corrosion research as a career. Persistent scientific effort is needed for continued progress in the conservation and preservation of metals.

These are days, however, when there is much for scientists to do and not nearly enough scientists to go around. In the face of expanding need for men of scientific training, there has been a continuing relative decline in the enrollment of students in science courses. If this trend toward a diminishing supply of scientists is to be reversed (and it is in the national interest that it should be), it will require the sympathetic interest of all of us who recognize the seriousness of the situation.

Diagnosis of the problem is simple: not enough intellectually able youth are being found and being persuaded to prepare for science careers. The reason for not going to college continues to be in part the need for financial assistance. Of those who do go a large proportion lack interest in science—indeed often have a distaste for the subject. It is to be feared that this attitude is the result of indifferent science teaching in the secondary schools. The majority of young people choose their careers during this period of their lives. Too often their teachers have little knowledge and no professional interest in any branch of science.

What is it like to be a chemist, a physicist or a biologist? What are the satisfactions of a scientist? Only a gifted teacher can convey inspirational answers to such questions. Such teachers might be more often attracted to the secondary schools by substantially higher salaries. Once obtained, the efforts of superior teachers should be devoted exclusively to the instruction of the talented students.

Eventually these measures should lead to the production of more scientists and smarter scientists, capable of making significant contributions to that fund of basic knowledge upon which the world's technology must depend to an increasing degree.

Bacterial Corrosion of Offshore Structures*

By J. A. CALDWELL* and M. L. LYTLE*

Abstract

Reports published by the British Admiralty and by individuals in England and the United States, show that sulfate-reducing bacteria can cause corrosion of iron under some conditions. Because of the importance of maintaining in good condition the steel piling of offshore structures in the Gulf of Mexico a research investigation of the possibility of bacterial corrosion of these installations was inaugurated. Laboratory tests were directed toward developing fairly pure cultures of sulfate-reducing bacteria and using them in both natural muds and synthetic culture media for the purpose of determining their effect on the corrosion rate of steel coupons under anaerobic conditions. Maximum corrosion rates obtained were of the order of 0.001 inch per year. Several assemblies of twenty coupons each were installed at a marine platform approximately seven miles off Grand Isle, Louisiana; the coupons on each assembly were spaced to extend a few feet above and a few feet below the mud line. Somewhat similar assemblies were installed immediately offshore at Barbour's Cut, near La Porte, Texas, and at the Crash-Boat Basin at Galveston, Texas. Results of the study show that the corrosion rate due to bacterial action is low, and that cathodic protection is a sufficient safeguard against bacterial corrosion.

IT HAS BEEN BELIEVED for some years that anaerobic bacteria play a part in the corrosion of iron and steel under certain conditions. The bacteria which seem to cause the major part of the corrosion are members of the genus *desulfovibrio,* and are usually referred to in the literature as *vibrio desulfuricans* and *sporovibrio desulfuricans.*[1] They are commonly called "sulfate reducers." These bacteria require oxygen in their metabolism, but are not able to use free oxygen from the air. However, by the reduction of sulfates commonly present in soils they are able to obtain a sufficient supply of oxygen. Ordinarily, additional requirements for the continued growth of sulfate-reducing bacteria are a neutral environment and the presence of moisture and organic matter. However, Butlin, Adams and Thomas[2] have reported the autotrophic growth of pure cultures of sulfate-reducing bacteria by using steel rods immersed in a culture medium as a source of hydrogen. Butlin and Adams[3] cultivated sulfate-reducing bacteria in a strictly mineral medium in an atmosphere of hydrogen containing 5 percent carbon dioxide.

In a number of instances, notably in submerged and buried locations, appreciable quantities of iron sulfide have been found among the products of corrosion of iron pipes. Moreover, it has been observed that the quantities of iron sulfide are sometimes in excess of the amounts which could be expected from determinations of the sulfur content of the metal or the soil in contact with the metal; this suggests the percolation of a water-soluble sulfur compound, possibly a sulfate, through the soil, with subsequent reduction to sulfide by bacteria and reaction of the sulfide with the iron of the pipe. Corrosion of this type in which iron sulfide is found is known to occur only in water-logged and poorly aerated soils and usually in those of heavy clay.

Mechanism of Bacterial Corrosion

In the normal corrosion of iron in the presence of an ample supply of oxygen, metal ions pass into solution at numerous points on the surface of the metal. These points are called "anodes." At the same time hydrogen ions are discharged at various other points on the surface of the metal; these points are called "cathodes." The release of hydrogen at the cathodes is a fundamental adjunct to the corrosion of the metal. The oxygen present in the surrounding solution combines with the discharged hydrogen, so that additional hydrogen can be discharged at any particular point, thus allowing corrosion of the metal to proceed. In heavy clay soils, in the absence of atmospheric oxygen, it appears that the corrosion process reasonably might be expected to come to a halt because of the accumulation of hydrogen on cathode areas, with no hydrogen-acceptor standing ready to remove it. According to the theory of von Wolzogen Kuhr as presented by Starkey and Wight,[1] the sulfate reducers act as depolarizers by removing the hydrogen at cathodic points. The hydrogen sulfide formed from the reduction of sulfates reacts with metallic ions at anodic points, forming the iron sulfide which is found upon inspection of the pipe adjacent to the soil.

Reported Cases of Bacterial Corrosion

Reports issued by the British Admiralty[4] have indicated that sulfate-reducing bacteria were responsible for corrosion of steel cages used in the causeway construction at Orkney and Shetland, Scotland and for rapid corrosion of mine cases in Malayan waters during World War II. Reports by Bunker[5,6] in England and Hadley[7,8] and Starkey and Wight[1] in the United States cite instances of pipe line corrosion apparently caused by sulfate reducers. Recently Doig and Wachter[9] have reported severe bacterial corrosion of oil-well casing in California at depths of several thousand feet below the surface of the earth.

Need for Research Investigation

Because of the importance of maintaining in good condition the steel piling of offshore structures in the Gulf of Mexico, an investigation has been made of the possibility of bacterial corrosion of these in-

★ A paper presented at a meeting of South Central Region, National Association of Corrosion Engineers, New Orleans, La., October 1-3, 1952.

* Humble Oil & Refining Co., Houston, Texas.

stallations. Steel piling submerged in mud of the ocean bottom would be vulnerable to attack if sulfate-reducing bacteria were active in the vicinity. The difficulty of inspecting such piling at the mud line, or interface between water and sediment, on a routine basis made it desirable to know whether corrosion caused by bacteria could be expected. Cathodic protection is normally applied to offshore structures to guard against electrolytic corrosion, but it was not known whether it would afford protection at the mud line against corrosion caused by sulfate reducers.

Aims of Research Investigation

The program for study of corrosion of offshore structures at the mud line was designed to determine:

1. Whether it is probable that corrosion of the steel is occurring at or below the mud line.
2. What the causes of corrosion are, if corrosion is occurring.
3. What steps can be taken to reduce such corrosion to a reasonable minimum.

Laboratory Test Procedure

A portion of the laboratory work was directed toward the isolation of fairly pure cultures of sulfate-reducing bacteria from samples of mud obtained from the ocean bottom at Humble Oil & Refining Company's Grand Isle Platform "A." The medium used for the isolation of the bacteria was a commonly used lactate medium. Because halophilic strains of sulfate-reducing bacteria were to be isolated, sodium chloride was included in the medium, giving a final composition as follows:

Substance	Amount
Distilled Water	1000 cc
NaCl	33.0 gm
K_2HPO_4	0.5 gm
NH_4Cl	1.0 gm
$MgSO_4{:}7H_2O$	2.0 gm
Sodium lactate	3.6 gm
$CaCl_2{:}2H_2O$	0.1 gm
Ferrous Ammonium Sulfate	Trace

This medium limited development to only a few bacteria other than those which were able to reduce sulfate to hydrogen sulfide under anaerobic conditions. Blackening of the iron salts by hydrogen sulfide in the medium indicated growth of the sulfate-reducing bacteria. Sub-cultures were made from the liquid medium on agar plates consisting of 2 percent agar in the above liquid medium. By "fishing" the black colonies which appeared on these plates fairly pure cultures of sulfate-reducing bacteria were isolated, as determined by visual observation of the colonies grown on agar and by microscopic examination of the individual colonies.

The second phase of the laboratory work was designed to determine the corrosion rates of steel specimens exposed under anaerobic conditions in sterile and inoculated liquid media in combination with clays and sands. The same lactate medium was used with minor modifications, such as addition of organic nutrients and of more magneisum or sodium sulfate. Mild carbon steel coupons, 1-inch x 3-inch x 1/16-inch were used in the tests. These coupons were cleaned with petroleum and ethyl ethers, weighed, placed in a glass container and sterilized by dry heat in an oven at 110-115 degrees C. for 3 to 4 hours. Sterile forceps were used to place the coupons in the medium. All liquid medium was sterilized in an autoclave and in most cases the clays and sands were sterilized in the same way. Exposure times in the culture medium varied; the minimum was 14 days.

The medium was inoculated either with suspensions of bacteria obtained by washing the colonies off agar plates with sterile salt solution, or by using 2 to 3 cc portions of a liquid culture of sulfate-reducing bacteria. All of the experiments were carried out at a temperature of 25-28 degrees C. In the experiments where clays or sands were used as a portion of the culture medium, the coupons were totally covered by the sand or clay in some cases and were covered to the extent of about 75 percent of their areas in others.

The coupons were cleaned and reweighed after their removal from the sterile and inoculated media. The weight losses of the coupons were calculated as inches of metal penetrated per year. Comparison of corrosion rates of coupons exposed in sterile medium with corrosion rates of coupons exposed in inoculated medium gave the change in corrosion rate brought about by bacterial action.

Technique for Maintaining Anaerobic Conditions

A standard procedure of using an alkaline solution of pyrogallol was adopted to remove oxygen from the cultures of bacteria and from both the sterile control and inoculated media used throughout the experiments. In a majority of the experiments flasks or large test tubes were used to hold the culture medium. A sterile 10 cc capacity test tube containing the alkaline pyrogallol was suspended inside the flask or test tube by means of a wire attached to the rubber stopper used to seal the container. A coating of paraffin was applied to the stopper to produce an air-tight seal.

Results of Laboratory Tests

Results of some of the laboratory tests are shown in Table I. For the most part the corrosion rates of

TABLE I

Corrosion Rates of Coupons in Various Culture Media

CULTURE MEDIUM	Incubation Period Days	AVERAGE CORROSION RATE IN./YR.	
		Sterile	Inoculated
Liquid lactate	14	0.0010	0.0009
Enriched liquid lactate	14	0.0007	0.0020
Liquid lactate and El Paso clay	14	0.0009	0.0009
Enriched liquid lactate and El Paso clay	14	0.0002	0.0006
Sea water and mud from Laguna Madre, Tex.	14	0.0002	0.0005
Sea water and mud from Grand Isle, La.	14	0.0002	0.0006
Enriched liquid lactate and mud from Grand Isle, La.	28	0.0003	0.0011
Enriched liquid lactate and Ottawa sand (20-30 mesh)	28	0.00006	0.0003
Enriched liquid lactate, El Paso clay, and Ottawa sand (20-30 mesh)	28	0.0002	0.0009
Liquid lactate, sea water, and El Paso clay	28	0.0005	0.0010
Liquid lactate, sea water, and El Paso clay*	28	0.0005	0.0007
Enriched liquid lactate and El Paso clay	84	0.0075	0.0092
Enriched liquid lactate and Ottawa sand (20-30 mesh)	84	0.00005	0.0001

* Fresh liquid medium and new coupons, but same clay.

the steel specimens exposed in the laboratory tests were low, being of the order of 0.001 inch per year. This figure is considerably lower than those obtained in laboratory tests in which similar coupons were exposed to corrosive oil-well fluids in which corrosion rates of about 0.02-inch per year were obtained. In general corrosion of steel coupons exposed in the inoculated media was uniform and pitting of the steel surfaces was not observed in any experiments where a good growth of the sulfate-reducing bacteria was maintained.

Coupons exposed in sterile liquid lactate medium had the same corrosion rate as those exposed in cultures of sulfate-reducing bacteria in the same medium. In an experiment in which l-cystine and additional $MgSO_4$ were added to the liquid medium there was an increased corrosion rate of the coupons exposed in the inoculated medium. The same corrosion rates were obtained for coupons exposed in sterile and inoculated medium consisting of a mixture of El Paso clay and liquid lactate medium. However, additives such as yeast extract, mannitol, and amino acids to this culture medium produced marked differences in the corrosion rates of the exposed coupons. The corrosion rates of the coupons exposed in the sterile control medium were reduced 80 percent, while the corrosion rates of the coupons in the inoculated media were reduced 30 percent; therefore, the coupons in the inoculated media were corroding several times faster, due to the stimulated growth of the sulfate-reducing bacteria.

Coupons were exposed in unsterilized samples of mud obtained from Laguna Madre, Texas, and Grand Isle, Louisiana. These muds contained sulfate-reducing bacteria as well as many others, so no additional inoculum was used. The muds in which the control coupons were exposed were sterilized. The coupons exposed in the muds in which the sulfate-reducing bacteria were active corroded at about the same rate as coupons exposed in the enriched liquid lactate and clay medium previously described. Addition of organic materials to the Grand Isle mud doubled the corrosion rates of coupons in the inoculated medium. The corrosion rate of the control coupons remained about the same.

Substitution of 20-30 mesh Ottawa sand for El Paso clay in the enriched liquid lactate medium reduced the coupon corrosion rate in both sterile and inoculated media by about 50 percent. Equal amounts of El Paso clay and 20-30 mesh Ottawa sand in combination with the enriched liquid lactate medium gave an increased corrosion rate for coupons in the inoculated medium. Control coupons were not affected.

Attempts to culture sulfate-reducing bacteria in mixtures of liquid lactate medium and ground silica (180 mesh) or in mixtures of liquid lactate medium and 50-60 mesh Ottawa sand were unsuccessful.

In an attempt to effect an increase in coupon corrosion rate the supernatant portion of the liquid culture medium was removed from El Paso clay after 28 days, and fresh liquid was added. Coupon corrosion rates for the second 28 day period were somewhat lower than for the first.

An experiment was performed in which coupons were exposed in El Paso clay over which enriched liquid lactate medium was poured. All of the liquid was taken up by the clay and cracks appeared during the course of the experiment. After 84 days visual examination of the coupons showed severe pitting in both sterile and inoculated clays. The corrosion rate of coupons in the sterile clay was 0.0075 inch per year; the corrosion rate in the inoculated clay was about 20 percent higher. Microscopic examination of the inoculated clay medium showed no motile bacteria, although there were black spots throughout the clay and it had a sour odor. Results of a similar experiment in which coupons were exposed in enriched liquid lactate medium and 20-30 mesh Ottawa sand showed no pitting and the corrosion rates were very low. Microscopic examination of the sand medium showed active bacteria. The experiment in which clay was used probably simulated some conditions found in marshy locations where the ground develops cracks during dry seasons. The sulfate-reducing bacteria would be inactive, but some of the products of their metabolism would still be present and could cause corrosion.

Field Tests, Grand Isle Platform "A"

During September, 1950, eight assemblies of twenty coupons each were installed along the northwest side of Humble Oil & Refining Co.'s Platform "A" off Grand Isle, La. Each group of coupons was fastened to a piece of 1-inch or 2-inch steel pipe about 10 feet long, equipped with a square steel plate at midpoint, the pipe perpendicular to the plate. There were nine 1-inch x 3-inch x 1/16-inch mild steel coupons above the plate spaced at intervals of six inches, and eleven coupons below the plate, spaced at intervals of either three or six inches. Coupons on four of the assemblies were in electrical contact with the pipe and the structure. Coupons on the other four assemblies were electrically insulated from the pipe and the structure. Enough additional pipe was attached to each assembly to allow the lower end of the assembly to penetrate the mud of the ocean floor to a depth of about five feet, the square plate serving as a device for locating the mud line. At the point of installation the water is about 50 feet deep; clamps were welded to the structure a few feet above the water line to hold the pipes. Details of the coupon assembly are shown in Figure 1.

Additional Field Tests

In order to determine the effects of less saline environments on the corrosion rate of steel, coupon assemblies somewhat similar to those used off Grand Isle were exposed for about 250 days each immediately offshore at Barbour's Cut, Harris County, Texas, and at the Crash-Boat Basin, Galveston, Texas. Nominal salinities at these locations are about 9,000 and 14,000 ppm chloride, respectively. The mud at Barbour's Cut was found to be black and sticky, and to possess a sour odor. The soil at Galveston contained more sand.

Cathodic protection at Barbour's Cut and the Crash-Boat Basin was obtained from magnesium

anodes. Current densities in milliamperes per sq. ft. ranged from 4.0 to 4.8 at Barbour's Cut, and from 1.4 to 5.4 at the Crash-Boat Basin.

Removal and Processing of Test Coupons

Four of the test coupon assemblies were removed in December, 1950, after exposure of 85 days. The coupons were removed and taken to the laboratory for cleaning and examination. Bacterial cultures were prepared by inoculating portions of the standard medium for sulfate-reducing bacteria with scrapings from eight insulated and eight cathodically protected coupons. The coupons were selected at 18-inch intervals, except some at shorter intervals at the mud line. Alkaline pyrogallol solution was used in the culture flasks, as previously described, in order to insure anaerobic conditions. After one month the original cultures were used to make sub-cultures.

Four more of the test coupon assemblies were removed in January, 1952, after an exposure time of 496 days. Bacterial cultures were made from scrapings from each coupon on one cathodically protected and one insulated assembly.

Results of Field Tests

In general, duplicate results of coupon weight loss determinations for both insulated and cathodically-protected assemblies agreed closely. Plots of the average values of rate of metal loss for coupons from the 85-day and 496-day tests at Grand Isle are shown in Figure 2. In each test it was found that the corrosion rates of cathodically-protected coupons were negligible. Corrosion rates for the insulated coupons in the 85-day test decreased from 0.0054-inch per year at a point 4½ feet above the steel plate to the value for the cathodically-protected coupons at a point about 2½ feet below the steel plate. Corrosion rates for insulated coupons from the 496-day test decreased from 0.0015-inch per year at a point 4½ feet above the steel plate to the value for the cathodically-protected coupons at a point 3½ feet below the steel plate. Solid mud was found on all four assemblies in the 85-day test at a point about 16 inches below the plate. The mud line at the end of the 496-day test was more difficult to determine, but the best estimate placed it at about one foot below the plate on three of the four assemblies.

Examination of coupons from the Grand Isle 496-day test showed that a hard, tightly adherent calcareous scale, light in color, had been deposited on the cathodically-protected coupons at and above the mud line. Below the mud line, the coupons were clean, with no hard scale and little mud attached. In no case was there any blackening of the coupon underneath the mud or scale. A somewhat less adherent and very black scale was found on the insulated coupons above the mud line. The surfaces of the coupons themselves were found to be black. Below the mud line, the coupons were identical in appearance with those in corresponding positions on the cathodically protected assembly.

X-ray analysis of scale from both cathodically protected and insulated coupons from the Grand Isle

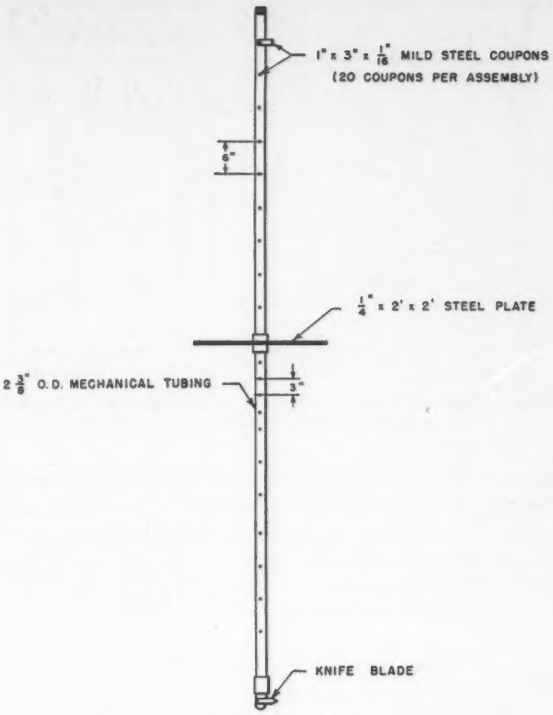


Figure 1—Test coupon assembly at Grand Isle.

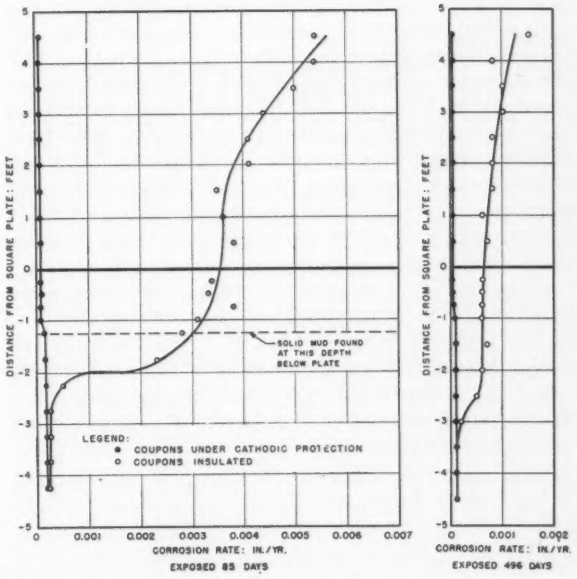


Figure 2—Corrosion rate of coupons at Grand Isle.

496-day test showed it to consist largely of aragonite. A qualitative test for iron sulfide gave positive results for scale from the insulated coupons only and it was present in very small amounts.

Weight losses for coupons exposed at Barbour's Cut and the Crash-Boat Basin are shown in Figure 3. Weight losses of coupons under cathodic protection at each place were negligible. Weight losses of insu-

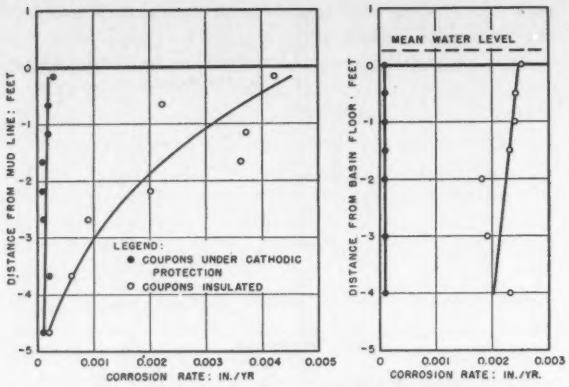


Figure 3—Corrosion rate of coupons at: Left—Barbour's Cut, exposed 253 days. Right—Crash-Boat Basin, exposed 252 days.

lated coupons in the mud at Barbour's Cut decreased from a value of 0.004-inch per year at a point just below the mud line to a negligible value almost five feet below the mud line. At the Crash-Boat Basin there was little change in corrosion rate with depth, all values being near 0.002-inch yer year.

Inspection of Bacterial Growths

Inspection of bacterial cultures inoculated with scrapings from sixteen coupons from the Grand Isle 85-day test showed good growth. Only one culture failed to develop sulfate reducers; this culture was inoculated from the lowest coupon on one of the cathodically-protected assemblies. Inspection of cultures inoculated with scrapings from the Grand Isle 496-day test showed that 27 out of 40 cathodically-protected and 38 out of 40 insulated coupons yielded scale samples which caused blackening in anaerobic culture in eight days or less. Scrapings from sixteen coupons from Barbour's Cut and fourteen coupons from the Crash-Boat Basin were used to inoculate culture media. Half of the coupons at each location were cathodically protected.

Although good growths of sulfate reducers were obtained from scrapings from the cathodically-protected coupons, it is believed that the bacteria had been growing only on the outside of the scale, where scale was present. As previously mentioned, there was no blackening of the surface of the cathodically-protected coupons.

Discussion of Results of Field Tests

It is apparent that the cathodic protection systems at all three locations were sufficient to keep the corrosion rates of the uninsulated coupons at a low level. The relatively high corrosion rates of the insulated coupons above the mud line at Grand Isle possibly were due to both oxygen corrosion and bacterial action. Calculations from the data on the 85-day and 496-day tests at Grand Isle show that 65 percent or more of the corrosion of coupons on the latter test probably occurred in the first 85 days. It will be noted that corrosion rates obtained at the mud line in the 496-day test at Grand Isle were about the same as those obtained in the laboratory tests. The difference in results obtained at Barbour's Cut and the Crash-Boat Basin suggest that corrosion of steel at some distance below the water-soil interface may be more serious for somewhat sandy soils than for those containing more clay and organic material.

Conclusions

1. Bacterial corrosion of iron in environments in which offshore structures are located is a possibility.
2. The corrosion rate due to bacterial action is low.
3. Cathodic protection is a sufficient safeguard against bacterial corrosion.

References

1. R. L. Starkey and K. M. Wight. Anaerobic Corrosion of Iron in Soil. Final Report of the American Gas Association Iron Corrosion Research Fellowship, 1945.
2. K. R. Butlin, Mary E. Adams and Margaret Thomas. The Isolation and Cultivation of Sulfate-Reducing Bacteria. *J. of General Microbiology*, **3**, 46 (1949).
3. K. R. Butlin and M. E. Adams. Autotrophic Growth of Sulfate-Reducing Bacteria. *Nature*, **160**, 154 (1947) August 2.
4. Admiralty Corrosion Committee Report, ACC/H 105.1/46.
5. H. J. Bunker. Microbiological Experiments in Anaerobic Corrosion. *J. Soc. Chem. Ind.*, **58**, 93 (1939) March.
6. H. J. Bunker. Microbiological Anaerobic Corrosion. *Chem. and Ind.*, **59**, 412 (1940) June 15.
7. R. F. Hadley. Microbiological Anaerobic Corrosion of Steel Pipe Lines. *Oil and Gas J.*, **38**, No. 19, 92 (1939) Sept.
8. R. F. Hadley. Methods of Studying Microbiological Anaerobic Corrosion of Pipe Lines. *Petro. Eng.*, **XI**, No. 6, Part I, 171 (1940) March; **XI**, No 7, Part II, 112 (1940) Apr.
9. Keith Doig and Aaron Wachter. Bacterial Casing Corrosion in the Ventura Field. *Corrosion*, **7**, No. 7, 212 (1951) July.

References on Plastics For the Corrosion Engineer*

By RAYMOND B. SEYMOUR*

WHILE the ravages of corrosion have been the subject of discussions for many years, until recently, too little has been done to counteract this costly industrial plague. Although corrosive forces were at work when man first formed simple metal tools, many centuries passed before even crude attempts were made to counteract its effects.

Fortunately for American industry, more progress in combating corrosion has been made in the last decade than in any previous period. The National Association of Corrosion Engineers, established in 1943, has grown to be recognized as the clearing house for activities associated with corrosion. Many of its members are considered authorities in the corrosion field. The growth of this association and its continued emphasis on corrosion prevention has been responsible to a large extent for the creation of a new technologist, the corrosion engineer.

Many corrosion engineers in training are seeking background information so they can make more effective contributions to industrial and public safety. The National Association of Corrosion Engineers is supplying this information through the monthly publication of CORROSION, biennial Bibliographic Surveys of Corrosion and other publications.

A survey of the abstracts under NACE Abstract Filing System Index headings 5.4 and 6.6 shows which journals are publishing what information on plastic materials of construction.

The corrosion engineer should also be informed of the availability of the following sources that will be of assistance:

Committee Activities

NACE TP-6:

The National Association of Corrosion Engineers has established Technical Practice Committee 6 under the heading of "Protective Coatings." This Committee includes the following sub-committees:

Surface Preparation (TP-6G)
Organic Coatings and Linings (TP-6A)
Corrosion Resistant Cements (TP-6K)

American Society for Testing Materials:

Committee D-11 on Rubber and Rubber-like Materials, Established in 1912.
Committee D-20 on Plastics, Established in 1937.
Committee C-3 on Chemical Resistant Mortars, Established in 1949.

Corrosion Committee of the British Iron & Steel Research Association

Protective Coatings' Sub-Committee

Conferences

The Gordon conferences meet each summer at New Hampton Institute and Colby Junior College in New Hampshire under the auspices of the American Association for the Advancement of Science, schedule annual discussions on protective coatings, plastics, high polymers and corrosion.

Symposia

Materials of Construction in the Chemistry Industry Conference—Birmingham University (England) April 18-20 (1950). These papers have been compiled and published by the Society of Chemical Industry, London (1950).

Trade Journal Reviews

Industrial & Engineering Chemistry:

Annual Materials of Construction Review—October issue—Reviews on cements, elastomers, plastics, paint and hard rubber. An article on specific problems in corrosion is featured monthly.

Chemical Engineering:

Biennial materials of construction report appears in one of the Fall issues. This report includes a directory of materials showing the manufacturer and contains a description and an outline of the most important application of cements, plastics, coatings and rubber. The Corrosion Forum is a monthly feature of *Chemical Engineering.* In past years, the emphasis has been on the effect of specific chemicals on various materials of construction. More recently, the corrosion resistance of specific materials to a large number of chemicals has been presented graphically.

Chemical Engineering Progress:

A plastics reference sheet is published monthly which includes physical properties and corrosion resistance of each specific plastic.

Materials and Methods:

Engineering File Facts on materials of construction are featured by this journal.

★Submitted for publication August 13, 1952.
* Atlas Mineral Products Company, Mertztown, Pa.

Handbooks

Chemical Engineers' Handbook. John H. Perry, 3rd Edition. McGraw-Hill Publishing Co., 1951, Sec. 21, Materials of Chemical Construction includes tables on chemical resistance of constructional materials.

Corrosion Handbook. H. H. Uhlig, John Wiley & Sons, 1948, includes five chapters on organic coatings.

Metal Finishing Guidebook. Finishing Publications, Inc. Each annual edition contains chapters on corrosion resistant tanks and linings, protective coatings and floor construction.

Plant Engineering Handbook. Wm. Staniar, McGraw-Hill Publishing Co., 1950, includes chapters on materials of construction.

Books

Protective Coatings:

Corrosion Resistant Linings: German Acetylene Chemical Industry, J. F. Ellis, BIOS Final Report No. 1055, Mapleton House.

Engineering with Rubber. Chapter 15, Walter E. Burton, McGraw-Hill Book Co., 1949.

Paint Film Defects. Manfred Hess, Reinhold Publishing Corp., 1951.

Prevention of Iron & Steel Corrosion. Dinsdale, Lonis Cassier Co., Ltd., London, 1948.

Protective and Decorative Coatings. Jos. J. Mattiello, U. S. Government Printing Office, 1945.

Protective and Decorative Coatings. Jos. J. Mattiello, Vols. I-V, John Wiley & Sons, 1941-46.

Protective Coatings for Metals. R. M. Burns and A. E. Schuh, Reinhold Publishing Corp., New York, 1939.

Protective Coatings for Metals. J. W. Gailer and E. J. Vaughan, Charles Griffin & Co., London, 1950.

Rubber in Engineering. Research Staff, Imperial Chemical Industries, Ltd., Chemical Publishing Co., 1946.

Symposium on Rubber. ASTM, 1932, pg. 113-134.

Plastics:

The Chemistry of Synthetic Resins. Carlton Ellis, Reinhold Publishing Co., 1935.

Chemistry of Commercial Plastics. R. L. Wakeman, Reinhold Publishing Co., 1947.

Handbook of Plastics. H. R. Simonds, D. Van Nostrand Co., Inc., 1943.

An Introduction to Engineering Plastics. D. W. Brown and W. T. Harris, Murray Hill Book Co., Inc., 1947.

Kunstoffe in Technische Korrosion Schutz. Krannich, J. W. Edwards Co., Ann Arbor, Mich., 1943.

A Manual of Plastics and Resins in Encyclopedia Form. Wm. Schack, Chemical Publishing Co., Inc., 1950.

Modern Plastics Encyclopedia and Engineers Handbook. Issued annually by Plastics Catalog Corp., New York.

Synthetic Resins and Rubbers. P. O. Powers, John Wiley & Sons, Inc., N. Y. C., 1943.

Corrosion Data Surveys:

Corrosion, Causes and Prevention. F. N. Speller, McGraw-Hill Book Co., 1951.

Corrosion Data Survey. G. A. Nelson, Shell Development Co., 1950.

Corrosion Guide. Erich Rabald, Elsevier Press Inc., 1951.

It is expected that the corrosion charts being published by Chemical Engineering and the corrosion data sheets being published by Chemical Engineering Progress will be available in book form when the surveys are completed.

Engineering Material:

Chemical Constitution and Properties of Engineering Materials. P. C. Carman, Edward Arnold & Co., 1948.

Chemical Engineering Plant Design. S. P. Vilbrandt, McGraw-Hill Book Co., 1949.

The Chemical Resistance of Engineering Materials. Hamlin and Turner, Reinhold Publishing Co., 1943.

Chemistry of Engineering Materials. 4th Edition, R. B. Leidhou and J. C. Warner, McGraw-Hill Book Co., New York, 1942.

Enginering Materials Manual. T. C. Dumond, Reinhold Publishing Corp., 1951.

Industrial Piping. C. T. Littleton, McGraw-Hill Book Co., 1951.

Materials of Construction. J. A. Bateman, G. P. Putnam Publishing Corp., 1950.

Materials of Construction. 8th Edition, Johnson-Withey-Aston, John Wiley & Sons, 1948.

Materials of Construction for Chemical Process Industries. J. A. Lee, McGraw-Hill Book Co., 1950.

Modern Chemical Processes. Vol. I & II, W. J. Murphy, Reinhold Publishing Corp., 1950-1952.

Acknowledgment

The author appreciates the assistance of J. D. Fenstermacher in the preparation of this article.

Studies on the Inhibition by Amines Of the Corrosion of Iron By Solutions of High Acidity*

By C. C. NATHAN

Introduction

THE ACTION of amines as inhibitors of the corrosion of iron by strong acids has been investigated in detail during the past twenty years. A summary of the theories of the inhibitor action was recently presented by Hackerman.[1] The present studies were undertaken as a part of a broader program which aims at uncovering of further information on

1) the mechanism of inhibition by various polar organic molecules,
2) correlation of inhibitor effectiveness with molecular structure in order to predict favorable structures for efficient inhibitors, and
3) development of improved testing methods for the prediction of inhibitor performance.

Techniques

Strip tests were run by immersing mild steel coupons 2 x ½ x ⅛-inch in HCl containing 1000 ppm of amine expressed as basic nitrogen. This concentration, while sufficient to reduce the normality of the acid from 1 normal to 0.93 N made no change in the pH of the solution (initially 0.2-0.3) as shown on a Beckman Model H meter. Solutions of the amine were prepared by adding the calculated quantity of the amine to the acid and agitating the solution until it was saturated. In the event the saturation value was exceeded, no attempt was made to determine the solubility of the amine nor to remove the undissolved portion.

Metal strips were cut from strip stock and then polished with successively finer grades of emery paper.* They were then scrubbed with kitchen cleanser, rinsed with water, then with acetone and dried. Immediately after weighing, the strips were immersed in small jars, each containing 100 cc of the inhibited acid. The jars were placed in a shaking machine for some 24 to 72 hours, although the usual duration of the test was 48 hours. Tests were conducted in an air-conditioned room maintained substantially at 77 degrees F. All tests were run in duplicate and blank runs on uninhibited HCl were always carried out simultaneously in order to compensate for fluctuations in room temperature. Weight loss was determined at the termination of a test after the coupons were removed from the solution, flushed with running water, rinsed in acetone and dried. Under the conditions of the test, the weight loss for uninhibited acid was of the order of a milligram per hour per strip. Duplicate determinations were usually reproducible to within ten percent of the total weight loss. The efficiency of an amine-containing acid compared to that of the uninhibited acid was calculated according to the formula:

$$\text{Percent Efficiency of Inhibition} = \frac{100\,(W_o - W)}{W_o} \qquad (1$$

where W is the weight loss of the coupon in the inhibited acid, and W_o is the loss in the uninhibited acid.

Powder tests were conducted by placing one gram of finely divided iron powder* in a flask and dropping 500 cc of acid containing the amine onto the powder. The evolved hydrogen was then measured by water displacement in a graduate and its volume measured as a function of time. The use of such powder for the study of relative corrosion rates has been described by Hackerman and Cook.[2] The specific sur-

C. C. NATHAN—Chemist with The Texas Company's Producing Department Laboratory in Bellaire, Texas since 1948, has been engineer in research and corrosion and other production problems. He holds a BS in chemical engineering from Rice Institute, 1940 and an MS and PhD in physical chemistry from University of Pittsburgh, 1942, 1948 respectively. From 1942 to 1944 he was employed by Monsanto Chemical Co. He was a naval reservist from 1944 to 1946. A native of Fort Worth, Texas he attended Houston public schools, is married and has three daughters.

Abstract

The present paper describes studies carried out on the corrosion of both steel strips and iron powder in solutions of 1 normal hydrochloric acid. These studies have been directed toward the evaluation of various aliphatic and aromatic amines as corrosion inhibitors and to the correlation of the structure of the amines with their adsorption characteristics and inhibitor efficiencies. It has been found that the effectiveness of the amines increases with molecular weight in the homologous series and that steric factors which would appear to be more favorable for the adsorption of the amine or its ion at the metal to solution interface increase the inhibition efficiency. These factors are discussed in detail. The series of amines investigated were the aliphatic straight and branched chain, aniline and its homologs, and N-alkylated derivatives, alkylated pyridines and pyridine homologs, and several dibasic aromatic amines.

★A paper presented at a meeting of South Central Region, National Association of Corrosion Engineers, New Orleans, La., Oct. 1-3, 1952.

*The Finest used was Metalite 240, manufactured by Behr-Manning Company.

* Baker's Analysed Reagent reduced iron powder.

face of the powder was approximately 0.2m² per gram as determined by adsorption of palmitic acid from its solutions in benzene by the method of Smith and Fuzek.[3] The temperature during the experiments was 77 degrees F.

The theoretical amount of hydrogen evolved per gram of iron is 435 cc under the conditions of the experiment and the experiment was usually terminated when 150 cc of hydrogen had been evolved or after two hours, whichever occurred first. With most of the inhibitors tested, the relation between the volume of gas evolved, V in cc and the time of evolution, t, in minutes could be closely represented by an equation of the form:

$$V = k \log (1 + bt) \qquad (2$$

Here b was a "universal" constant having the value of 0.1 for all the systems reported and k was a constant characteristic of the system being studied. A similar equation also expressed the relation between the amount of gas evolved from solution of the powder in uninhibited acid and the time. Since the constant b is common to both the inhibited and uninhibited acid, the inhibition efficiency can also be expressed as follows:

$$\text{Percent Inhibition Efficiency} = \frac{100\,(k_o - k)}{k_o} \qquad (3$$

where k is the characteristic constant for the inhibited acid under study, and k_o is the constant for the uninhibited acid.

The amount of acid consumed by the iron was less than five percent of the amount originally present and the pH of the spent acid solutions was substantially equal to that of the fresh acid. That the dissolution products of the iron were not causing a poisoning of the powder surface with a reduction of reaction rate was shown by treating fresh samples of powder with spent acid. The reaction rates with the spent acid were equal to those of the fresh acid within the limits of reproducibility of the experiments. On the other hand, the formation of an adsorbed film on the powder could easily be demonstrated by taking the powder which had been in contact with a good inhibitor, e.g., tributyl amine for several hours until the reaction rate had fallen off nearly to zero and adding fresh acid to this powder. There was no further evolution of hydrogen after twenty-four hours of contact between the treated powder and the fresh acid. Similar experiments with steel strips have been reported by Mann et al.[4]

In Figure 1 are shown the data for hydrogen evolution from powders in contact with uninhibited HCl and with various inhibitors. Table I gives the inhibition efficiencies by both the strip and powder method for some fifty of the amines tested. Figure 2 presents these same data in graphic form.

Discussion

A number of conclusions may be drawn from the above data. In the main, the data can be explained on the basic assumptions that an adsorbed film of

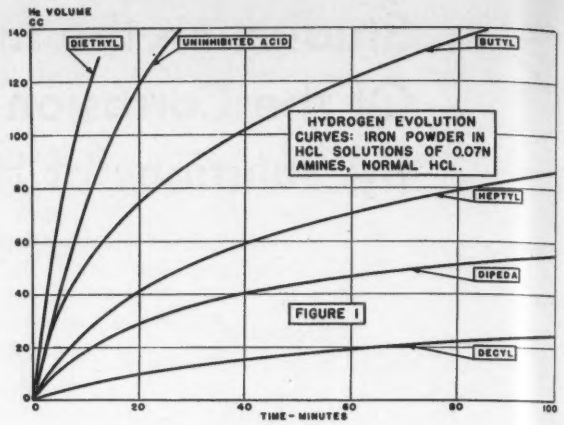


Figure 1

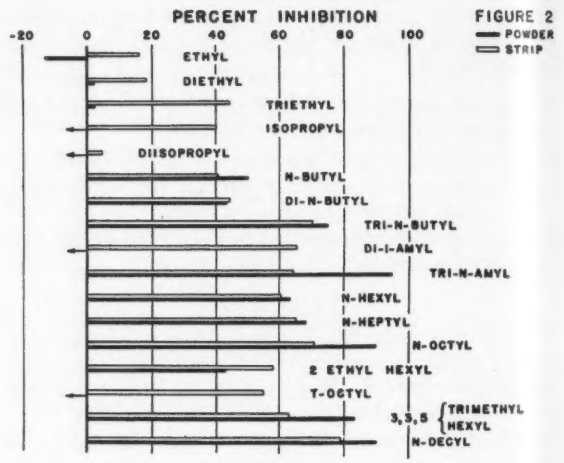


Figure 2

inhibitor builds up on the surface of the metal and that this film is responsible for the decreased rate of attack of the metal by acid. The film acts as a diffusion barrier either for the migration of hydrogen ions to the cathodic areas of the metal or the migration of ferrous iron away from the anodic areas. Work by Ch'iao and Mann[5] on measurements of cathodic potential of steel in sulfuric acid solutions containing amine inhibitors points to the first alternative. If it is assumed that the film does not form instantaneously but requires a measurable time to be adsorbed and oriented, then the corrosion rate should vary with time until the adsorbed film has reached equilibrium with the solution from which it is formed. It may be shown mathematically that the total amount of metal dissolved will then vary linearly either with the square root or with the logarithm of the time, depending upon the distribution of diffusing ions through the film barrier.[6] Evidence for such behavior is the logarithmic relation between volume of hydrogen evolved and time of attack. The logarithmic curves are obtained in most cases showing inhibition by the powder test.

There are two main differences between the powder test and the coupon test:

1) The surface area exposed is about a thousand-fold greater with the powder and
2) The time involved is of the order of an hour or so with the powder, as compared with several days on the coupons.

Adsorption should be of greater importance on the powder because of increased surface. However, if adsorption is slow, the powder will show a smaller inhibition than will the coupon test in which sufficient time is allowed for adsorption equilibrium and the happenings of the first hour are not weighted so heavily in the observed results. It thus appears that what is really being measured in the powder test is the ease and/or speed of equilibration of an adsorbed barrier film.

In view of this, it is somewhat surprising that the two methods agree so closely on so many materials. An agreement of 5 percent or better between the two is as much as can be expected in view of the lack of reproducibility of duplicate runs particularly on the coupon tests. It can be seen that for inhibitors of low efficiency (less than 30 percent as shown by coupon) the powder method usually gives an even lower figure than does the coupon. As the homologous series of aliphatic amines is ascended, good agreement is observed for the butyl through heptyl amines. For inhibitors of high efficiency (above 60 percent as shown by coupons), the powder method gives higher results than does the coupon. However,

TABLE I—Inhibition Efficiency

AMINE	By Coupon	By Powder
Ethyl*	16	—13
Diethyl*	18	2
Triethyl*	44	2
i-Propyl*	40	negative
Di-i-Propyl*	4	negative
n-Butyl	40	50
Di-n-butyl	44	43
Tri-n-butyl	70	75
Di-i-amyl	65	negative
Tri-n-amyl (sat) (liquid)	64	95
n-Hexyl	60	63
n-Heptyl	65	68
n-Octyl (sat) (liquid)	71	90
2-Ethyl hexyl*	58	43
t-Oxtyl*	55	negative
3,3,5 Tri-methyl-hexyl	53	83
n-Decyl (sat) (liquid)	79	90
Benzyl	41	39
α-Methyl-benzyl*	40	18
β-Penyl-ethyl*	50	56
Cyclo-hexyl*	32	18
Di-cyclo-hexyl (sat) (solid)*	33	30
Di-2-Ethylhexyl (sat) (liquid)*	71	91
Aniline	3	18
Methylaniline	35	30
Dimethylaniline	36	32
Ethylaniline	56	48
Diethylaniline	49	62
Butylaniline	36	32
Benzylaniline	59	84
o-Toluidine	32	20
m-Toluidine	31	32
p-Toluidine	40	32
Dimethyl-o-toluidine	48	52
Dimethyl-m-toluidine	55	54
Dimethyl-p-toluidine	47	44
Ethyl-o-toluidine	38	49
Ethyl-m-toluidine	60	59
2,4, Xylidine*	61	64
2,5, Xylidine*	44	40
Methylenedianiline**	56	60
N,N,N′,N′ Tetramethyl** methylenedianiline	48	68
N,N,N′,N′ Tetraethyl-** methylenedianiline	55	82
o-Tolidine (sat) (solid)	37	72
s-Diphenyl-ethylenediamine (DIPEDA)	58	82
2-n-Amylpyridine (sat) (liquid)	35	48
4-n-Amylpyridine (sat) (liquid)	37	68
2-(5 nonyl) pyridine (sat) (liquid)	55	80
4-(5 nonyl) pyridine (sat) (liquid)	54	95
Pyridyl polymer (sat) (liquid)*	81	100

Materials marked with an asterisk (*) were technical commercial products used without further purification. Those marked with a double asterisk (**) were recrystallized technical materials. All others were of the highest purity available from the manufacturer, either Eastman Kodak Company or Mathieson Chemical Company and were used without further treatment.

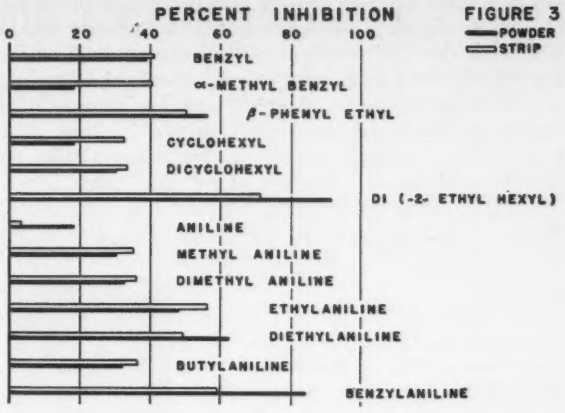


Figure 3

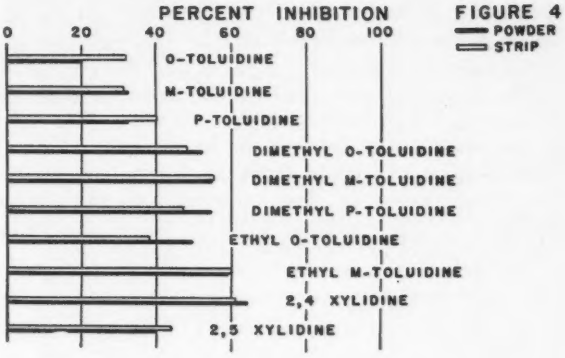


Figure 4

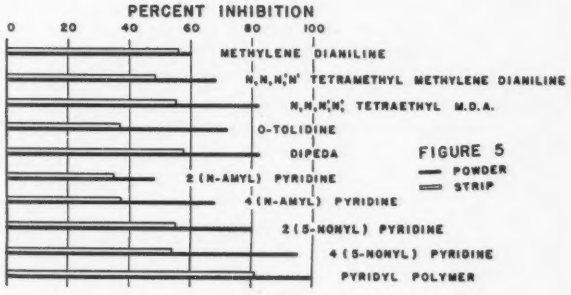


Figure 5

it will be seen that in most of these cases, e.g., octyl and decyl amines, alkylated pyridines, the solutions are saturated and contain an excess of liquid amine or "oil" which can plate out mechanically around the powder particles and thus protect them from attack. When the insoluble amine is in solid form, e.g., dicyclohexyl amine, this mechanical action is not observed and the powder and coupon methods agree.

It can be seen that branching of the alkyl chain decreases inhibitor efficiency, *c. f.* n-octyl, 2-ethyl hexyl and t-octyl amine; n-octyl, 3,3,5 tri-methyl hexyl and n-decyl; dibutyl and di-isoamyl; benzyl and α-methyl benzyl; but that the reduction in efficiency is more pronounced on the powder than on the coupons. Compare also the powder results on isopropyl and di-isopropyl amines. These findings

are in accord with the theory that the amine molecule or ion is adsorbed with its polar end on the metal and with the hydrocarbon radical directed normally away from the metal. For the inhibitor to be effective, it should be strongly adsorbed and the geometrical nature of the nonpolar radical should be such that a close interlocking of the hydrocarbon chains is possible. Molecular models show that such interlocking is not possible when the chains are branched. Work by Zisman,[7] *et al*, on oleophobic films also shows that such tight films cannot be formed from branched molecules.

It is seen that in general the efficiency of inhibition increases with molecular weight in a homologous series. This is shown for the alkyl amines, substituted anilines, and alkylated pyridines. This is in agreement with Traube's[8] rule of adsorption. Similar results have been reported on aliphatic and aromatic amines by Mann,[5] et al, and on acridine and its derivatives by Rhodes and Kuhn.[9]

For isomeric amines, it appears that the geometry of the molecule may predict the relative ease of adsorption. Thus o-toluidine shows a lower efficiency by the powder method than do the m and p isomers. This is in accord with steric hindrance caused by the methyl group in close proximity to the amino group. A similar reasoning explains the difference in inhibition efficiency of the 2-5 and 2,4 Xylidine.

When the structure of the molecule is such that more than one part of it can be adsorbed, increased inhibition is observed; c. f. toluidines and tolidine; DIPEDA and the methylene dianilines. Here again the powder method gives higher results than does the coupon. Ascending the series of methylene dianilines gives marked increase in powder efficiency with molecular weight, although methylene dianiline and its methyl and ethyl homologs give substantially the same inhibition as shown by coupons.

Acknowledgment

The author expresses his appreciation to the management of The Texas Company Producing Department for giving their permission to publish this paper.

References

1. Norman Hackerman. *Corrosion*, **8**, 143 (1952).
2. E. L. Cook. Ph.D. Thesis, University of Texas (1950).
3. J. F. Fuzek and Hilton A. Smith. *J. Am. Chem. Soc.*, **68**, 229 (1946).
4. C. A. Mann, B. P. Lauer and C. T. Hultin. *Ind. Eng. Chem.*, **28**, 159 (1936).
5. Shih-Jeh Ch'iao and C. A. Mann. *Ind. Eng. Chem.*, 39, 910 (1947).
6. Merwyn B. Brodsky and Daniel Cubicciotti. *J. Am. Chem. Soc.*, **73**, 3497 (1951).
7. W. C. Bigelow, D. L. Pickett and W. A. Zisman. *J. Coll. Sci.*, **1**, 513 (1946).
8. Weiser. Colloid Chemistry, John Wiley & Sons, New York (1939), p. 226.
9. F. H. Rhodes and W. E. Kuhn. *Ind. Eng. Chem.*, 21, 1066 (1929).

Graphical Multiple Correlation Of Corrosion Data*

By O. B. ELLIS

THERE ARE MANY occasions when the evaluation of corrosion data by statistical methods can be of great value. Many statistical methods are available and the choice of the most suitable procedure generally is made by the preference of the user for a particular method. Mathematical methods are tedious and, when the relationships between variables cannot be expressed by straight lines, are of questionable value.

Mordecai Ezekiel,[1] in "Methods of Correlation Analysis," has discussed a graphical procedure of multiple correlation. The method has the advantage of giving visual evidence of the relationships between variables as the work progresses and these relationships can be straight lines or curves. Furthermore, if a variable is found to have little or no effect, it can be discarded at any time. Also, it is possible to include additional variables during the progress of the study.

The purpose of this discussion is to demonstrate the mechanical procedure involved in the initiation and completion of a graphical multiple correlation of corrosion data. The data chosen for demonstration of the method are four-year atmospheric weight losses of a group of low-alloy steels. The problem is to determine how variations in the composition of the steels have affected their atmospheric corrosion resistance. The composition and weight loss data of the samples are shown in Table I. Each sample consisted of five 4-inch by 6-inch specimens. The weight loss data are the averages of the five specimens. The consistency of behavior of samples of five specimens is indicated by the small value of the standard deviation of those five specimens. Note that the samples have been numbered consecutively from 1 to 20. It is important that the identity of each sample be maintained throughout the study.

The first step is to choose a variable in composition and plot it against weight loss. In this case nickel was chosen. Past experience has shown nickel to have a pronounced effect on atmospheric corrosion. Therefore, nickel should show a strong influence and be a good choice for the first approximation.

As the points are plotted they are identified by the code number. Then each point, or the average of several points of identical nickel content, is connected by a lightly drawn line as shown in Figure 1. This helps in estimating the shape and position of the curve to be drawn through the plotted points. It may be a straight line or it may be a curve as shown in Figure 1. It is not necessary that this first curve

O. B. ELLIS—Senior Research Engineer, Armco Steel Corp., received a BS in chemistry in 1922 and was an MS in physics in 1924 from University of Louisville, Ky. After employment at Armco's Ashland, Ky., plant in 1929 he transferred to the company's research laboratories in 1932 and became supervisor of corrosion research activities.

Abstract

The evaluation of corrosion data by statistical methods often is desirable in order to obtain maximum useful information from the data. This discussion is concerned with a graphical method for a multiple correlation analysis involving several variables. The graphical procedure is easier to use than mathematical procedures. Also, it provides visual evidence of the relationship between variables as the work progresses. The method is not limited to simple linear functions.

For purpose of illustration, weight loss data from an atmospheric exposure of low alloy steels are studied. The method is described step by step and the effect of concentration of nickel, manganese, phosphorus and silicon on weight loss is shown. The final results of the graphical analysis are compared with a mathematical analysis of the same data.

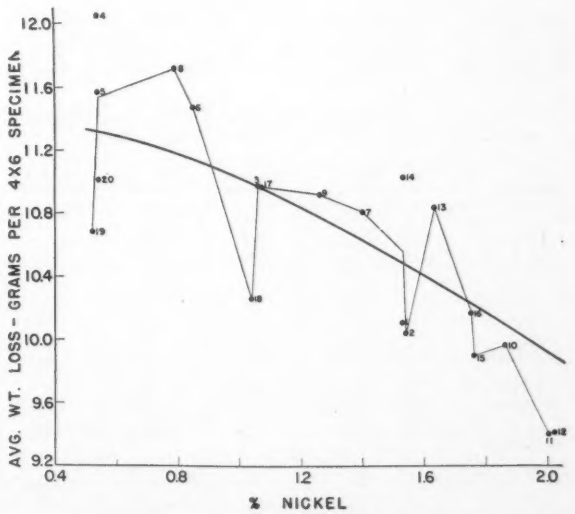


Figure 1—Apparent relation of weight loss to nickel content on first approximation of effect of nickel.

★A paper presented at the Ninth Annual Conference, National Association of Corrosion Engineers, Chicago, Ill., March 16-20, 1953.

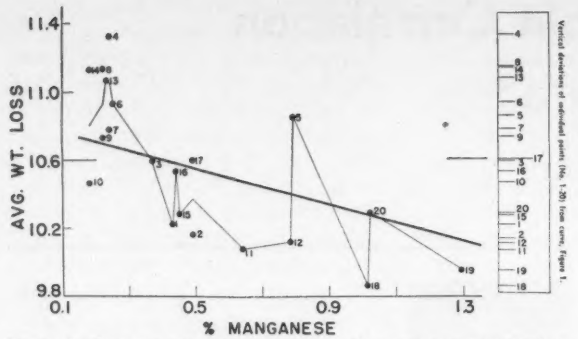


Figure 2—First approximation of effect of manganese, adjusted to average value of nickel.

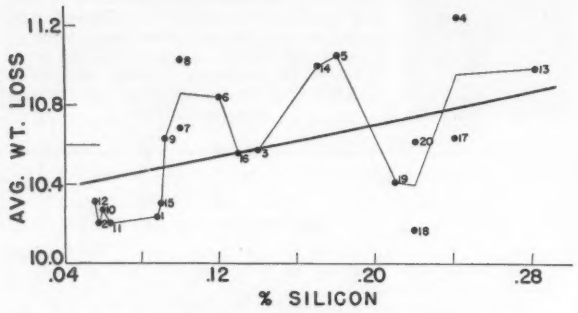


Figure 3—First approximation of effect of silicon, adjusted to average values of nickel and manganese.

be an accurate representation of the effect of the variable. Errors made in the slope or shape of the curve will correct themselves later. However, it is advisable to draw a straight line, if possible. If the data should conform to a curve this will become evident later, whereas a curve drawn initially may be difficult to change. Also, there is a tendency to draw lines at a steeper slope than is justified by the data. Therefore, it becomes advisable to use some degree of restraint in making the first approximation.

This line shown in Figure 1 then represents the apparent relation between nickel content and weight loss, and may be regarded as the first approximation of the effect of nickel. If nickel were the only variable, and if there were no errors in the observed weight losses, then all the points should lie on the line that has been drawn. The vertical deviations of the points from the line represent the combined effects of other variables, the errors in the observed weight losses and error in estimating the position of the line.

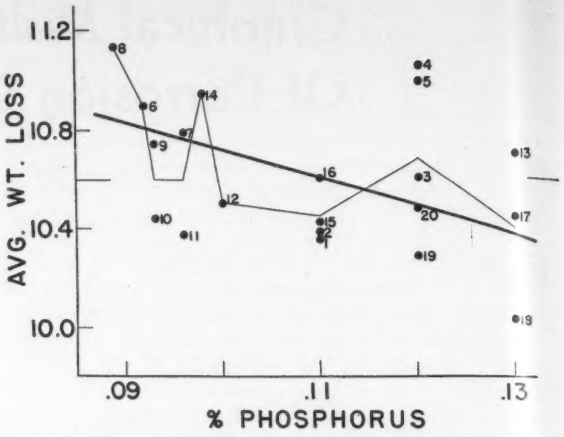


Figure 4—First approximation of effect of phosphorus, adjusted to average values of nickel, manganese and silicon.

These deviations will now be plotted against another variable. To do this it is convenient to transfer the magnitude of the vertical deviation for each point to a small slip of paper which can be discarded later. The piece of paper is marked near the center of one edge with a reference line. This reference line is moved along the nickel line of Figure 1, and the vertical deviation of each point is marked, together with the corresponding code number.

A second variable is chosen. In this case manganese was selected. A reference line is drawn parallel to the abscissa on which the manganese concentrations are placed. This line is at the approximate numerical average (10.6 grams avg. wt. loss) of the weight losses. The exact position is not important because the magnitude of the weight losses indicated on the ordinate no longer has any real significance with respect to the variable being plotted. However,

TABLE I—Chemical Analysis and Weight Loss Data of Twenty Samples of Low Alloy Steel

Code No.	Nickel Percent	Manganese Percent	Silicon Percent	Phosphorus Percent	Copper Percent	Carbon Percent	Sulfur Percent	Weight Loss Grams per 4 x 6" Spec. (Average of 5 Specs.)	Std. Dev. σ
1	1.53	0.43	0.088	0.11	0.72	0.08	0.025	10.10 Grams	0.17
2	1.54	.49	.058	.11	.72	.09	.024	10.03	.21
3	1.06	.37	.14	.12	1.14	.08	.023	10.97	.13
4	.54	.24	.24	.12	.98	.08	.028	12.05	.22
5	.54	.79	.18	.12	1.28	.10	.027	11.57	.12
6	.85	.25	.12	.092	.88	.09	.019	11.47	.29
7	1.40	.24	.10	.096	.88	.10	.019	10.80	.24
8	.79	.22	.10	.089	.88	.08	.015	11.72	.24
9	1.26	.22	.092	.093	.90	.09	.010	10.91	.22
10	1.86	.18	.060	.093	1.30	.09	.009	9.96	.35
11	2.00	.64	.064	.096	.54	.11	.025	9.39	.03
12	2.02	.78	.056	.10	.54	.11	.027	9.40	.20
13	1.63	.23	.28	.13	.67	.06	.031	10.83	.19
14	1.53	.18	.17	.098	.77	.11	.018	11.02	.18
15	1.76	.45	.090	.11	.73	.10	.030	9.89	.21
16	1.75	.44	.13	.11	.73	.11	.027	10.16	.18
17	1.07	.49	.24	.13	.74	.09	.026	10.96	.24
18	1.04	1.01	.22	.13	.74	.09	.026	10.25	.13
19	.52	1.29	.21	.12	.98	.06	.029	10.68	.26
20	.54	1.02	.22	.12	.98	.07	.029	11.01	.13
Average	1.262	0.498	0.143	0.109	0.855	0.090	0.0234	10.658	0.196

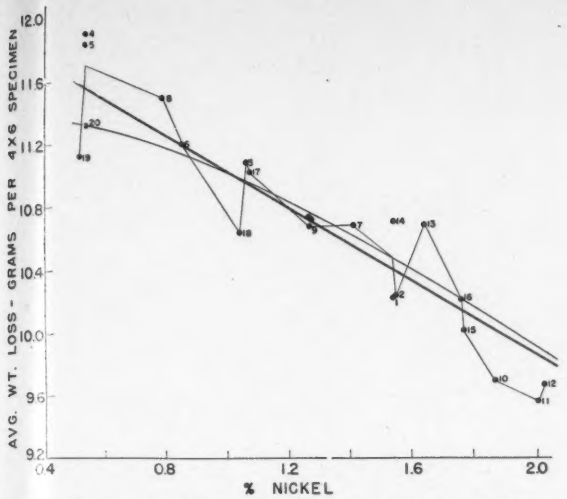


Figure 5—Second approximation of effect of nickel, adjusted to average values of manganese, silicon and phosphorus.

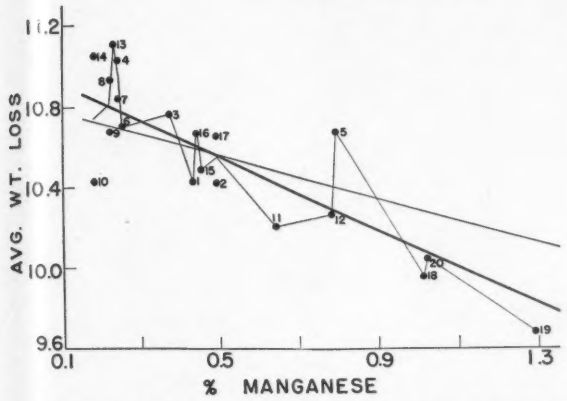


Figure 6—Second approximation of effect of manganese, adjusted to average values of nickel, silicon and phosphorus.

it is important that the same ordinate scale be maintained throughout the study. The reference line on the slip of paper showing the deviations is placed on the reference line of the manganese plot, as shown in Figure 2. The deviations from the nickel line are then plotted against manganese concentrations, numbering each point as was done previously.

The points are connected and the first estimate of the effect of manganese is drawn. The vertical deviations from this manganese line are marked on a new slip of paper as was done from the nickel curve. These deviations are plotted against the third variable; in this example it is silicon. A reference line is drawn parallel to the abscissa on which the silicon concentrations are placed. This line is at the approximate numerical average of the weight losses. The reference line on the slip of paper showing the deviations from the manganese curve is placed on the reference line of the silicon plot as shown in Figure 3. The best estimate of the effect of silicon is drawn, as shown in Figure 3.

The vertical deviations from the silicon line are then marked on a slip of paper. These deviations are plotted against the fourth variable, phosphorus, as

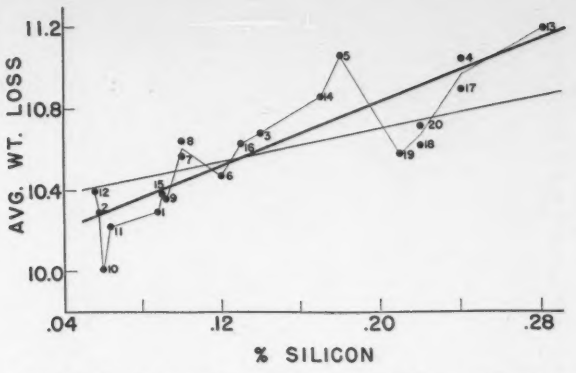


Figure 7—Second approximation of effect of silicon, adjusted to average values of nickel, manganese and phosphorus.

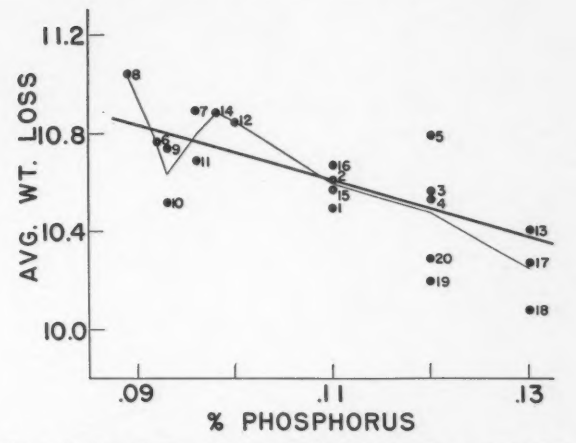


Figure 8—Second approximation of effect of phosphorus, adjusted to average values of nickel, manganese and silicon.

shown in Figure 4. The line estimating the effect of phosphorus is drawn and the vertical deviations from the phosphorus line again marked on a slip of paper as has been done previously for nickel, manganese and silicon.

Now is the time to go back and see if the incorporation of manganese, silicon and phosphorus as variables has had any effect on the first estimate of the effect of nickel. The nickel curve is redrawn lightly from Figure 1, as shown in Figure 5. The vertical deviations from the phosphorus curve are plotted above and below the nickel curve by sliding the reference line on the slip of paper along the first nickel curve. Now a new curve is drawn, as shown by the heavy line in Figure 5. Note that a straight line now is a better representation of the points than a curve.

Deviations are marked as previously and plotted against the first approximation of manganese, as shown in Figure 6. The new curve is drawn and the deviations again marked on a slip of paper. These deviations from the second approximation of manganese are plotted against the first approximation for silicon, as shown in Figure 7. Deviations are again marked as before and plotted against the first approximation for phosphorus, as shown in Figure 8.

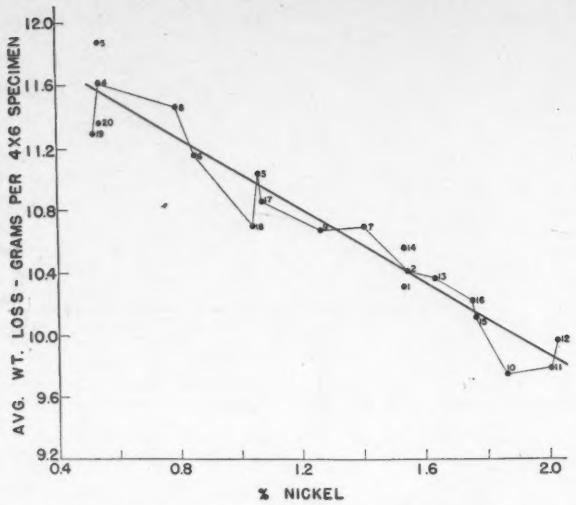


Figure 9—Third approximation of effect of nickel, adjusted to average values of manganese, silicon and phosphorus.

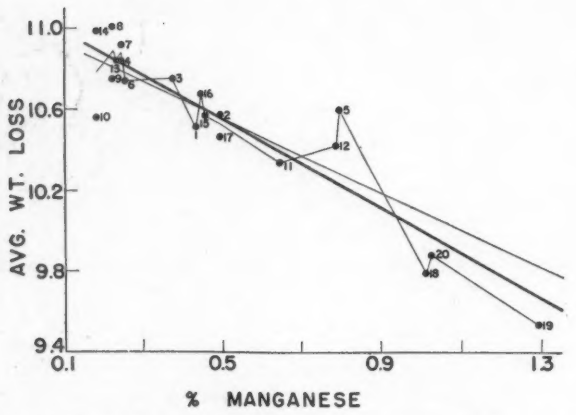


Figure 10—Third approximation of effect of manganese, adjusted to average values of nickel, silicon and phosphorus.

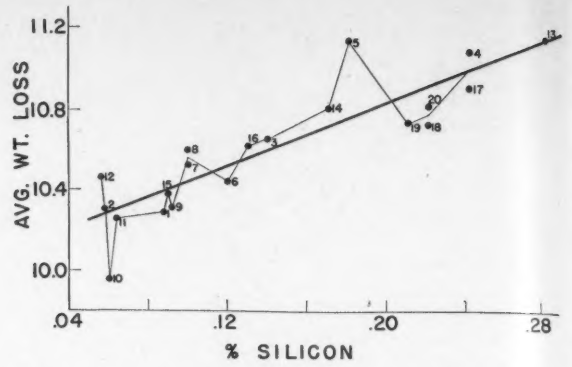


Figure 11—Third approximation of effect of silicon, adjusted to average values of nickel, manganese and phosphorus.

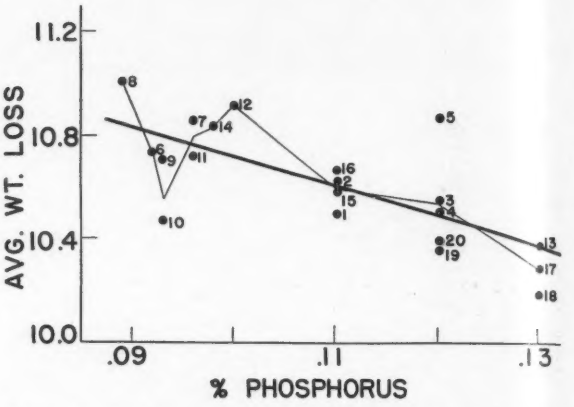


Figure 12—Third approximation of effect of phosphorus, adjusted to average values of nickel, manganese and silicon.

Note here that no new line needs to be drawn for phosphorus.

The above process is repeated until no further improvements can be made in the estimated curves. The successive curves, and the changes that have

TABLE II

Computation of Functional Values Corresponding to Independent Variables of the Estimated Value of X_o, and the Residual for Each Average Value of X_o

CODE	X_1 Ni	X_2 Mn	X_3 Si	X_4 P	$f(X_1)$	$f(X_2)$	$f(X_3)$	$f(X_4)$	$\Sigma f(X)$	$\Sigma f(X) + a = X_o'$	X_o	$X_o - X_o' = Z$
1	1.53	0.43	.088	0.11	10.39	10.62	10.40	10.60	42.01	10.21	10.10	— .11
2	1.54	.49	.058	.11	10.38	10.55	10.28	10.60	41.81	10.01	10.03	.02
3	1.06	.37	.14	.12	10.94	10.69	10.60	10.48	42.71	10.91	10.97	.06
4	.54	.24	.24	.12	11.55	10.75	10.98	10.48	43.76	11.96	12.05	.09
5	.54	.79	.18	.12	11.55	10.23	10.75	10.48	43.01	11.21	11.57	.36
6	.85	.25	.12	.092	11.19	10.80	10.52	10.81	43.32	11.52	11.47	— .05
7	1.40	.24	.10	.096	10.54	10.75	10.44	10.76	42.49	10.69	10.80	.11
8	.79	.22	.10	.089	11.26	10.85	10.44	10.84	43.39	11.59	11.72	.13
9	1.26	.22	.092	.093	10.71	10.85	10.41	10.80	42.77	10.97	10.91	— .06
10	1.86	.18	.060	.093	10.02	10.89	10.29	10.80	42.00	10.20	9.96	— .24
11	2.00	.64	.064	.096	9.85	10.39	10.31	10.76	41.31	9.51	9.39	— .12
12	2.02	.78	.056	.10	9.82	10.24	10.27	10.71	41.04	9.24	9.40	.16
13	1.63	.23	.28	.13	10.28	10.84	11.14	10.37	42.63	10.83	10.83	.00
14	1.53	.18	.17	.098	10.39	10.89	10.71	10.74	42.73	10.93	11.02	.09
15	1.76	.45	.090	.11	10.13	10.60	10.41	10.60	41.74	9.94	9.89	— .05
16	1.75	.44	.13	.11	10.14	10.61	10.56	10.60	41.91	10.11	10.16	.05
17	1.07	.49	.24	.13	10.93	10.55	10.98	10.37	42.83	11.03	10.96	— .07
18	1.04	1.01	.22	.13	10.97	9.98	10.91	10.37	42.23	10.43	10.25	— .18
19	.52	1.29	.21	.12	11.58	9.68	10.87	10.48	42.61	10.81	10.68	— .13
20	.54	1.02	.22	.12	11.55	9.97	10.91	10.48	42.91	11.11	11.01	— .10

$$a = \overline{X}_o - \frac{f(X_1) + f(X_2) + f(X_3) + f(X_4)}{n} = -31.80$$

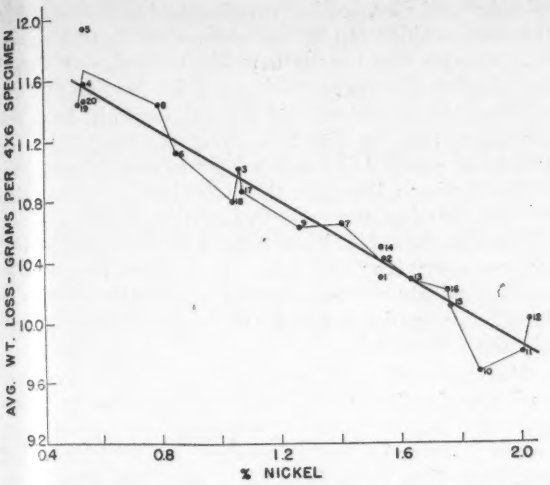


Figure 13—Fourth approximation of effect of nickel, adjusted to average values of manganese, silicon and phosphorus.

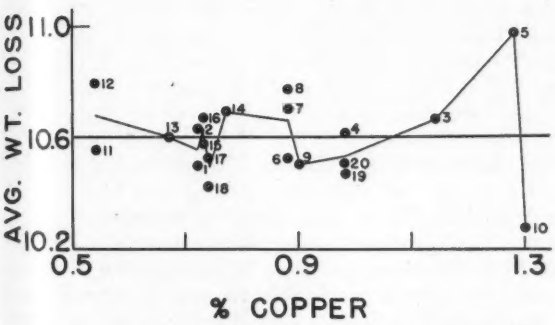


Figure 14—Vertical deviations from nickel curve (Figure 13) plotted against copper. Note that copper has no effect.

resulted from additional approximations, are shown in Figures 9, 10, 11, 12 and 13.

The last three curves show no change from the previous estimates. The vertical deviations, therefore, have not changed since the manganese curve (Figure 10) was drawn. As there have been no changes in the vertical deviations there can be no further change in the manganese curve. Therefore it is concluded that no further improvement can be made in the curves for nickel, manganese, silicon and phosphorus and the estimates as shown in Figures 10, 11, 12 and 13 are regarded as final.

If it is suspected that other variables that have not been considered may have some effect, these variables con now be plotted against the vertical deviations from the last curve, Figure 13. For example, if these vertical deviations are plotted against copper it will be found that no definite trend can be established, as shown in Figure 14. Therefore, it is concluded that copper has no effect on the atmospheric corrosion resistance of these alloys.

From the final curves, as shown in Figures 10, 11, 12 and 13 it is concluded that nickel, manganese and phosphorus have a beneficial effect on the atmospheric corrosion resistance of these alloys, but that silicon has a detrimental effect. These conclusions

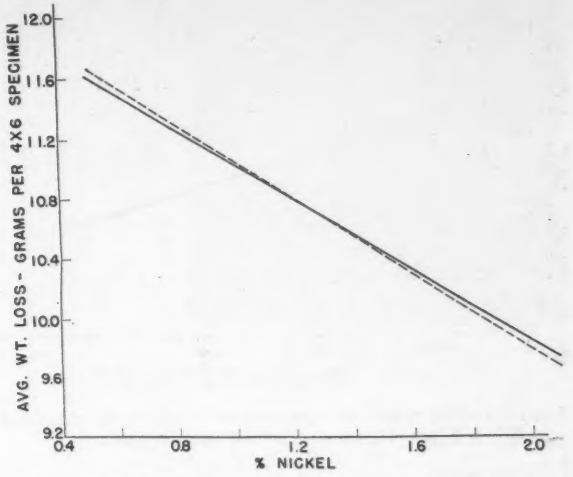


Figure 15—Final graphical approximation of effect of nickel (Figure 13) versus calculated approximation.

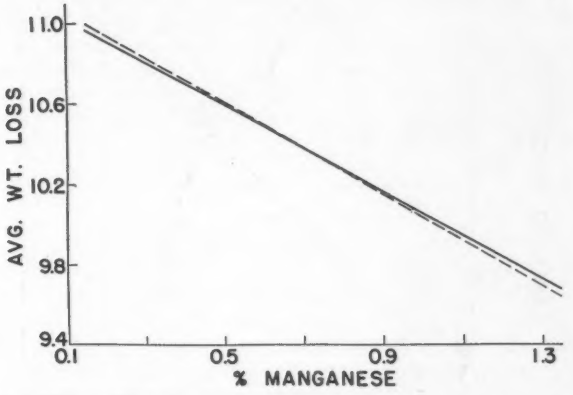


Figure 16—Final graphical approximation of effect of manganese (Figure 10) versus calculated approximation.

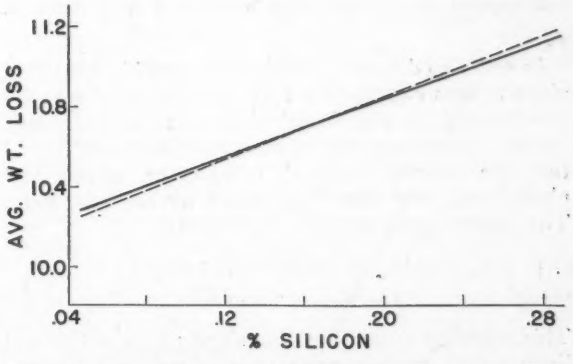


Figure 17—Final graphical approximation of effect of silicon (Figure 11) versus calculated approximation.

apply only to the ranges of chemical composition represented by these particular alloys and cannot be extrapolated to other alloys of different base composition, nor can the effects of individual elements be extrapolated beyond the limits of composition given in Table I.

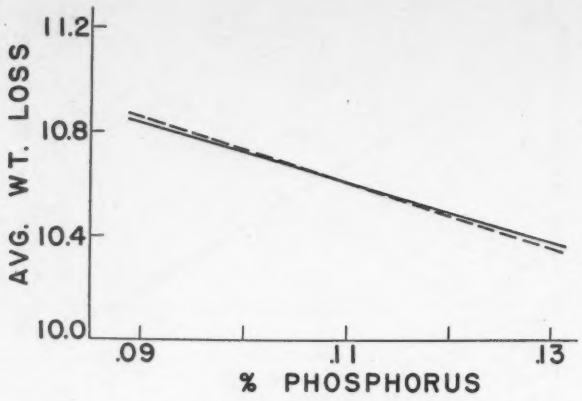


Figure 18—Final graphical approximation of effect of phosphorus (Figure 12) versus calculated approximation.

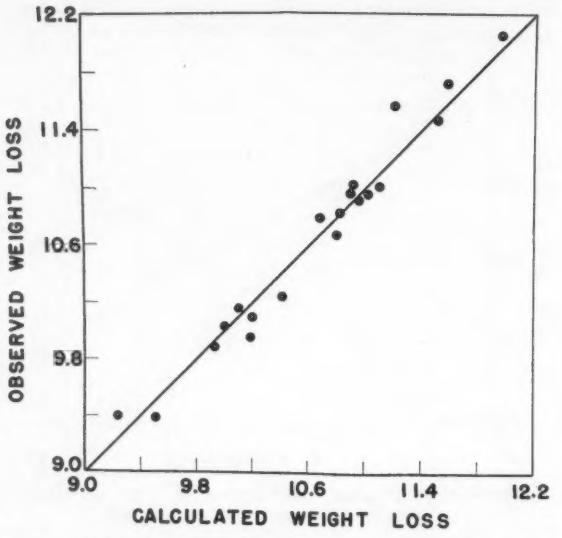


Figure 19—Observed weight losses versus weight losses estimated from final graphical approximations shown in Figures 10 to 13 (Table II).

In order to demonstrate that the graphical method gives results comparable to a mathematical correlation analysis, a mathematical correlation was made for the twenty samples after it had been established that the effects of nickel, manganese, silicon and phosphorus could be represented by straight lines. The following equation was derived:[2]

$$X_o = 13.601 - 1.228\ Ni - 1.141\ Mn + 3.788\ Si - 12.502\ P$$

This equation determines the slope of the calculated lines, which are shown in comparison with the approximations obtained by the graphical procedure in Figures 15, 16, 17 and 18.

These curves have demonstrated conclusively that relationships established by a graphical method can be in excellent agreement with those calculated by mathematical procedures. With a large number of samples and advance information and assurance that the relationships can be represented by straight lines, it is possible that the mathematical calculation would be simpler. However, with no prior knowledge regarding the magnitude of the relationship between variables, nor the shape of the probable curve, the graphical method is much easier to use. Then there is the further advantage that variables can be added or eliminated at any time during the progress of the work. For example, in this work the original pencil curves were completed in about four hours. The mathematical analysis required nearly three times as long because of the great number of arithmetic calculations required.

Having established certain relationships between variables, it often is important or desirable to determine the extent to which the observed variance between samples has been explained by the established relations. The procedure for doing this also is described by Ezekiel, and can be demonstrated by continuing with the curves shown in Figures 10 to 13.

A table is prepared showing the composition of the samples studied. Then the indicated weight losses are estimated from the appropriate curve for each variable, as shown in Table II, and tabulated as $f(X_1)$, $f(X_2)$, $f(X_3)$ and $f(X_4)$. The summation of these four functions is as shown under $\Sigma f(X)$. The average of $\Sigma f(X)$ is subtracted from the average of the observed weight losses. This gives the value of the constant "a."[3] The constant "a" is added to each value of $\Sigma f(X)$ to determine the calculated weight loss, X'_o. A comparison of observed weight loss, X_o, and calculated weight loss, X'_o, shows the extent to which the approximations have or have not explained the observed weight losses. Visual evidence of the agreement can be had by plotting the calculated weight losses against the observed weight losses, as shown in Figure 19.

If the calculated and observed weight losses are in perfect agreement, then all the points would lie on a straight line inclined at an angle of 45 degrees to either axis. The deviations of the points from this line are a measure of the extent to which the total variance of the observations has not been explained.

The explained variance has been calculated as 0.965 for the group of twenty samples. Also, the estimated explained variance for the universe from which the sample was drawn is estimated to be 0.956. This is a correlation coefficient of 0.977.

This discussion has shown how corrosion data can be evaluated by graphical correlation methods to determine the individual effect of several variables. The procedure is not difficult and can give results that are dependable.

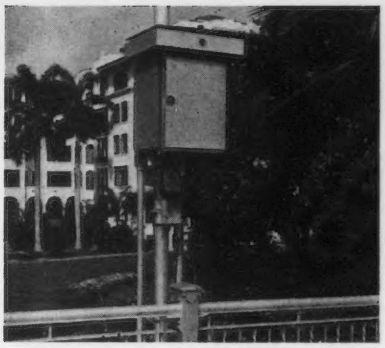
References

1. Mordecai Ezekiel. Methods of Correlation Analysis, Second Edition, Chapters 14 and 16. John Wiley & Sons, New York.
2. *Ibid.* Appendix 1.
3. *Ibid.* Pages 237 and 238.

Topic of the Month

Cooperative Corrosion Protection Benefits Miami Utilities

By D. T. ROSSELLE



Rectifier installation of joint cathodic protection system at Miami.

D. T. ROSSELLE—Supervisor of Cable Maintenance Results on the staff of the general plant manager of Southern Bell Telephone and Telegraph Co., Atlanta, Ga., has been employed more than 21 years by this company in plant and engineering work. He has been actively associated with corrosion mitigation work for 12 years.

IN MIAMI, corrosion prevention is like the city's excellent weather—a continuous year round affair enjoyed by all of the utilities serving the city. Cathodic protection can be used to protect individual plant but in urban areas the return currents frequently are dissipated on adjacent structures. It is a relatively simple job to provide cross bonding between these structures to overcome this condition and problems of this type are best solved on a cooperative, rather than an individual basis. The Miami "story" is an excellent example of how a cooperative effort improved the corrosion protection of underground metallic structures.

The street railway system in Miami was discontinued in November, 1940. This system had been providing a reasonable amount of cathodic protection and when it was no longer available, galvanic currents circulated and corrosion increased year by year. Both telephone and power companies were experiencing serious damage. In this area the corrosion was accelerated by low earth resistivity and the presence of various types of soil.

By 1948 the rate of loss was so great it became imperative to take action. The power company was particularly concerned with its downtown underground cable network. It secured competent engineering advice and initially proposed an installation of ten 50-ampere rectifiers. These were located on the perimeter of the downtown area with ground beds in Biscayne Bay and the Miami River. The area covered is roughly one square mile.

All utilities were notified and cooperative tests were made at the time the installation was energized. The telephone company provided circuits and relays that permitted all rectifiers to be energized and deenergized from a single control point. Calibrated bonds were placed between the telephone cables and power cables adjacent to each rectifier connection. Normal bonding to other structures was generally sufficient. These tests indicated that with minor changes a reasonable degree of protection could be obtained.

Rather than resort to a complicated inter-billing arrangement, the telephone company purchased one of the rectifier installations and later added another 50-ampere rectifier in the center of the area. The control circuits that were used on the initial tests were converted to alarm circuits and even though the power company owns most of the rectifiers the telephone company maintains these alarm circuits and notifies the power company immediately of the failure of any installation as a further contribution in this cooperative endeavor.

The benefits of this installation are manifold. Failures of both power and telephone cables due to corrosion have been practically eliminated and there has been a marked reduction in corrosion losses of both water and gas pipes in the area.

Probably the best result of this program was the formation of a group that was originally known as the Miami Electrolysis Committee. It is currently operating as "The Greater Miami Corrosion Control Committee." This committee meets quarterly and every operator of subsurface structures in The Greater Miami Area is represented as are other firms interested in corrosion generally. Notice of any additions or changes to existing installations are sent to the secretary who formally notifies all members. All participating members welcome cooperative tests to determine the influence of their installations. Meetings are generally of the round table discussion type and are well attended.

The results obtained, not only in downtown Miami, but in the entire Greater Miami Area have proved so satisfactory that all people concerned are actively supporting the committee. It appears that this approach to the solution of corrosion to subsurface structures should be applicable in most situations.

NACE News

Two More Sections Are Authorized for NACE

SECOND ANNUAL MEETING OF BOSTON SECTION—Seated at the speaker's table at the May 6 Second Annual meeting of Boston Section are, in the usual order: J. Dwight Bird, The Dampney Co., Boston, secretary-treasurer, re-elected for another term; E. J. Titsworth, Koppers Co., Inc., Boston, retiring chairman; F. L. LaQue, The International Nickel Co., Inc., New York, guest speaker; John Swift, Arthur D. Little, Inc., Cambridge, newly-elected chairman; A. Orman Fisher, Monsanto Chemical Company, Everett, new vice-chairman; O. W. Robertson, Corrosion Engineering Company, Somerville, chairman of the program and arrangements committee. New section officers assumed office June 1.

Boston Section Elects New Slate of Officers

New officers elected to serve for a year beginning June 1 by Greater Boston Section are: John Swift of Arthur D. Little, Inc., Cambridge, chairman; A. Orman Fisher, Monsanto Chemical Company, Everett, vice-chairman; J. Dwight Bird, The Dampney Co. Boston, was reelected secretary-treasurer.

The election was held at a dinner meeting at Hotel Beaconsfield, Brookline, attended by 96 members and guests, the largest attendance yet recorded by the section. F. L. LaQue, of The International Nickel Company's Corrosion Engineering Section spoke on "Some Anomalies of Corrosion." A lively question and answer period followed.

McFarland Addresses Metropolitan N. Y. Section

Fifty-nine members and guests of Metropolitan New York Section heard Roland McFarland, of Hills-McCanna Company, Chicago describe "The Application and Recent Developments of the Hills-McCanna Saunders Patent Diaphragm Valves" at a dinner meeting April 29. Mr. Saunders detailed the many different types of valve linings and diaphragms and discussed their ability to handle acid and caustic solutions. Mr. McFarland implied thick linings were superior to thin linings and that diaphragms are a compromise between inertness and flexibility.

Correspondents Named

C. F. Pogacar, The Atlantic Refining Co., Inc., Philadelphia, has replaced Derk Holsteyn as correspondent of Corrosion magazine representing Petroleum Refining. S. K. Coburn of The Association of American Railroads, Chicago, succeeds L. M. Mosher as correspondent for the Transportation Industry.

Air Conditioning Water Corrosion Is Discussed

Problems associated with the control of corrosion by waters used in air conditioning equipment were discussed by Sidney Sussman, Chief Chemist for Water Service Laboratory, Inc., New York City, at the May 8 meeting of Philadelphia Section. Dr. Sussman's discussion was oriented around the problems arising in three types of water circuits: 1) Once through cooling water systems using ground water, 2) Open recirculating systems and 3) Closed recirculating systems.

"The Use of Plastics in Chemical Plants," presented by Walter M. Bruner, Supervisor, Application Research Section of the Polychemical Department of E. I. DuPont de Nemours & Co., Inc., covered major commercial plastics and compared them on the basis of cost and physical properties.

The dinner meeting was held at the Poor Richard Club.

Pittsburgh Sounds Out Members on Program

Pittsburgh Section is making a canvass of member preferences for program topics for its 1953-54 program. Members have been asked to rate the 1952-53 program on its interest to them personally and to indicate which of several types of program they prefer.

Eleven suggested topics for the new program were listed and members asked to indicate their relative interest in them. Suggestions were asked also concerning persons who might be asked to present programs before the section.

A similar canvass of member interests recently was completed by Houston Section.

British Columbia and Columbia River Basin Areas Are Entered

The addition of the Columbia River Basin Section, to be organized in Washington and the British Columbia Section, at Vancouver will bring the number of local sections of NACE to 34. Western Region's board of trustees has authorized formation of a Columbia River Basin Section by Mark Adams of State College of Washington. Canadian Region has recognized the British Columbia Section and officers have been named.

Western Region's trustees approved formation of the Columbia River Basin Section at an April 1 meeting in Los Angeles.

Officers of the British Columbia Section have been named as follows: F. Forward, Dept. of Mining & Metallurgy, University of British Columbia, chairman; F. M. Cazalet, British Columbia Electric Railway, vice-chairman; B. H. Levelton, British Columbia Research Council, University of British Columbia. All are of Vancouver.

G. I. Russell, Canadian Region chairman also reported work is proceeding on establishment of sections at Montreal and Edmonton.

New England Section Hears C. J. Vandervalk

C. J. Vandervalk, Technical Director of the Pigment and Chemical Division of Lead Industries Association, spoke to members of Southern New England Section April 1 on "Metal Protective Paints." He covered surface preparation, prime and finishing coats, pigments and vehicles from the chemical and physical points of view and paint performance.

George E. Best, North East Region vice-chairman, told of the April 29 regional board meeting scheduled for New York City and the regional technical meetings to be held at Buffalo May 19 and at New Haven October 7.

Vance N. Jenkins Named

Vance N. Jenkins, a former president of NACE has been named program chairman for the 1953 Western Region Conference to be held in November or December, 1953. Mr. Jenkins is with the Research Center, Union Oil Co. of Cal., Box 218, Brea, Cal.

•

Technical material from CORROSION has been reprinted recently in Belgium and British publications.

Southwestern Ohio Section Nominates

Nominations for officers for Southwestern Ohio Section were made at an April 28 meeting at the Manchester Hotel, Middletown, Ohio. Nominations were announced by Joseph A. Creevy, Newport Steel Corp., Newport, Ky. as follows: Arthur D. Caster, Engineering Dept. City of Cincinnati, for chairman; Walter A. Luce, The Duriron Co., Dayton, Ohio, for vice-chairman; Alfred D. Jenss, Ampco Metal Inc., Cincinnati, for secretary; L. M. Lederer, Inner-Tank Lining Corp., Cincinnati, treasurer. Four trustees were nominated as follows: L. B. Routson, Western Union Telegraph Co., Cincinnati; R. B. Stephenson, Dayton Power and Light Co., Dayton; William P. Strader, The Duriron Co., Dayton and Mr. Creevy.

Under direction of G. H. Klouman and O. B. Ellis, the group toured the Middletown plant of Armco. Of the 50 persons present 23 were members.

The March 31 meeting, with 46 attending of whom 31 were members, heard reports on activities at the Chicago Conference from some 21 members who attended.

Charles G. Munger of Amercoat Corp., South Gate, Cal., spoke on protective coatings and their uses.

Two Papers Will Be Given at San Diego

Two technical papers on corrosion problems of regional interest will be given at a June 17 meeting of San Diego Section. F. O. Waters, with the City of San Diego Water Department will speak on "Some Aspects of Corrosion in the Water Industry" and K. D. Bennett, with Ryan Aeronautical Company, will speak on "Some Aspects of Corrosion in Aircraft Components."

L. J. GORMAN

Lawrence J. Gorman, pioneer member of NACE died in Potsdam, N. Y. in April. Mr. Gorman was a former director of NACE and active chairman of Technical Practices Committee 16-D, "Tests and Surveys of Electrolysis and Corrosion of Cable Sheaths."

Mr. Gorman was one of the two delegate members on the Inter Society corrosion Committee, representing the American Institute of Electrical Engineers. He was one of the electric light and power group representatives on the Joint Committee between the Bell Telephone System and the Edison Electric Institute. He did valuable work in the joint studies that were made, and his technical information was of a high calibre, according to technical men who knew him.

The number on Mr. Gorman's NACE application is 167. It was received in the early days of NACE, before the organization had a date stamp, but is dated March 23, 1944.

For 38 years, Mr. Gorman was associated with the Consolidated Edison Company of New York, retiring in April, 1951. The month of his retirement he affiliated himself with Robin Beach Engineers Associated, staying with them until his health failed.

Schmidt and Seagren Named on ISCC for NACE

H. W. Schmidt, chairman of NACE's Technical Practices Committee and George W. Seagren have been named representatives of the National Association of Corrosion Engineers on the Inter Society Corrosion Committee. This committee is composed of representatives of engineering, technical and trade organizations doing corrosion work or interested in corrosion control.

Mr. Schmidt is with Dow Chemical Company, Midland, Mich., while Mr. Seagren is with Mellon Institute of Industrial Research, University of Pittsburgh, Pittsburgh.

Nuclear Engineering Meeting Is Planned

University of Michigan will sponsor a meeting on nuclear engineering June 20-26, 1954 to which foreign engineers and scientists working on atomic energy will be invited. Major divisions of the program include Materials and Construction, Miles C. Leverett, General Electric Company; Nuclear Reactor Engineering, James A. Lane, Atomic Energy Commission; Reactor Fuel Refining and Preparation, John Clegg, Batelle Memorial Institute.

•

NACE's 10th Annual Conference and Exhibition will be held at Kansas City March 15-19, 1954.

FEDERATED METALS OFFERS NEW REPORT: "CATHODIC PROTECTION WITH ZINC ANODES"

Federated's Corrosion Advisory Service offers you, without obligation, a new report titled, "Cathodic Protection With Zinc Anodes," prepared by Ebasco Services Inc. for the American Zinc Institute. This new publication reports additional findings obtained since the first report was issued in November, 1951. In it you will find important and valuable facts that have influence on the proper applications of zinc anodes. Use coupon below for your free copy.

Zinc Anodes are available from Federated in standard lengths of 3 ft. and 5 ft. They are cast of Special High Grade Electrolytic Zinc in cross-sections of 2 sq. in. and 4 sq. in. Each has full length chemically-bonded steel core rod. Silver-soldered connecting wires can be attached if desired.

If your protection system is designed for magnesium anodes, ask for the Federated booklet, "Magnesium Anodes for Cathodic Protection."

Federated Metals Division
AMERICAN SMELTING AND REFINING COMPANY
120 BROADWAY, NEW YORK 5, N. Y.
In Canada: Federated Metals Canada, Ltd., Toronto and Montreal

Federated first in the non-ferrous field. SMD

Please send me FREE copy of

☐ Cathodic Protection With Zinc Anodes ☐ Magnesium Anodes for Cathodic Protection

NAME_____

COMPANY NAME_____

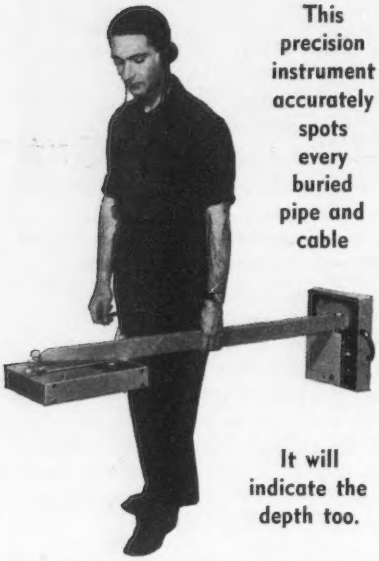
COMPANY ADDRESS_____

CITY_____ ZONE____ STATE_____

WILKINSON LINE LOCATOR

DESIGNED RIGHT

BUILT RIGHT



This precision instrument accurately spots every buried pipe and cable

It will indicate the depth too.

This substantial carrying case is supplied.

The WILKINSON LINE LOCATOR provides low cost insurance against trouble.

Its dependability is recognized by leading utilities everywhere.

WILKINSON PRODUCTS COMPANY

3987 Chevy Chase Drive

PASADENA 3, CALIFORNIA

Tel. SYlvan 0-4314

Permian Basin Section Seeks Advice on Holding Corrosion Tour in West Texas

Permian Basin Section of NACE is seeking expressions of interest in another corrosion tour to be held in the West Texas area this fall. Three of the tours have been held, attended by persons interested in the performance of corrosion control measures used on oil production equipment. The tours involve visits to areas where tanks and other equipment have been made available for inspection, followed by discussion sessions.

Persons who are interested in attending such a tour this fall are requested to write to John A. Knox, Secretary-Treasurer, Permian Basin Section, NACE, Box 310, Midland, Texas. A tentative registration fee of $17.50 is being considered.

Lightweight Mobile X-Ray Is Developed

A lightweight, mobile, 15 ma, 85 kw x-ray unit has been developed by the National Bureau of Standards for the United States Army. The unit, which incorporates standardized components for ready interchange irrespective of manufacturer, was designed to supply the need for such a device for combat operations. It has been tested satisfactorily to meet the needs of both medical treatment and combat service.

All pieces of the device are designed to withstand transportation and storage at temperatures between —50 degrees and 150 degrees F and over a wide humidity range. Materials used were selected for resistance to climatic change and adaptability to rust-proofing and fungicidal treatment. Either commercial or portable power may be used. Film processing techniques were designed to operate with a minimum of water.

•

More than 60 percent of the readers of CORROSION are engineers or do engineering work.

BOOK REVIEWS

Electrical Code Diagrams. By B. Z. Segall. Vol. 1, 754 pages, Vol. 2, 898 pages, 8½ x 11. 3100 illustrations. McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. Per copy, $25.00.

Based on the 1951 edition of the National Electrical Code, these volumes provide information whereby the code rules can be checked via the diagrams. Background material explains the code. The author, who has been connected with the code since 1927 and who issued a private edition of code diagrams some years ago, has given courses in the code to hundreds of wiremen, contractors, engineers and others. (Orders for the book will be accepted by B. Z. Segall, 2801 Joseph St., New Orleans 15, La.)

Micrometallurgy Is Gillette Lecture Topic

Micrometallurgy will be the topic selected by Jerome Strauss, vice-president of Vanadium Corp. of America, for the annual H. W. Gillett Memorial Lecture, jointly sponsored by the American Society for Testing Materials and Batelle Memorial Institute. The lecture will be delivered during the 1953 ASTM meeting at Atlantic City on June 30. The lecture will explain the effect of minute quantities of elements on various metals and alloys.

Rossini to Present 27th Marburg Lecture

Dr. Frederick R. Rossini, Silliman Professor and Head of the Department of Chemistry and Director of the American Petroleum Institute Research Laboratory, will present the 27th Edgar Marburg Lecture on "An Excursion in Petroleum Chemistry."

Pipe Lost in Gulf Found With Locator

T. E. Orrell, surveyor for George S. Klausler, Ltd., a marine insurance underwriter, recently located $16,000 worth of pipe lost overboard from a barge in the Gulf of Mexico three miles offshore from Corpus Christi, Texas with an electronic pipe locator.* Despite the fact salt water makes operation of electronic devices difficult, the several piles of pipe, scattered over about 250 yards and in 32 feet of water, were located by the device. A diver verified the finding of the pipe.

The pipe locator was mounted in the bow of a wooden skiff and rowed over the area in which the pipe was believed to have fallen overboard.

The sketch of the Corpus Christi channel shows the approximate location of the piles of pipe. The indicated areas are approximately 20 to 30 feet long and 4 to 6 feet wide. Mr. Orrell reported strong vibrating sounds were recorded in these areas with the locator.

The Klausler company has used this locator successfully to recover tools and equipment lost in the Ohio and Mississippi rivers.

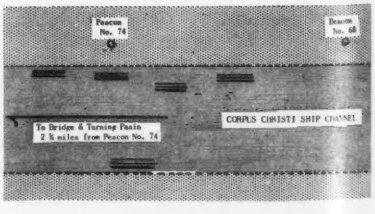


Figure 1—Black horizontal lines show approximate locations of pipe in Corpus Christi channel as indicated by the pipe locator.

* Wilkinson Line Locator, Wilkinson Products Co., Pasadena, Cal.

NACE Cooperates in Coming Corrosion Courses

Short courses on corrosion subjects in which the National Association of Corrosion Engineers is cooperating or which are being operated wholly by sections of NACE are as follows:

Fourth Annual Short Course on Corrosion held at Centenary College, Shreveport, sponsored by Shreveport Section. This course, for field foremen, superintendents and plant personnel is a very popular annual event. This usually is held in September.

Texas A & M College and NACE are cooperating in a short course to be given at College Station in the latter part of September. Prof. J. D. Lindsay of the Department of Chemical Engineering is arranging the course.

University of Illinois is offering a short course on cathodic protection October 12-16. This is the first short course in which NACE has participated devoted wholly to one of the major areas of corrosion. In addition to material on principles of electrochemistry and electric circuit theory, there will be lectures on economics and management problems, design and application, instruments and measurement techniques and field testing practices. Twenty-seven one hour lectures are scheduled in the five day course.

Other short courses not as well developed include a short course devoted entirely to marine corrosion and another course devoted to cathodic protection. Both of these are scheduled for the West Coast.

A short course seminar for the fall is being planned for the University of Oklahoma.

The next general short course on corrosion to be held on the West Coast is planned for February, 1954, at Washington State College, Pullman.

Norman Hackerman, chairman of the NACE Education Committee also reported there is considerable activity in colleges and universities across the country in introducing the study of corrosion into the regular curriculum. Among the universities known to have the matter under consideration are University of Tennessee, Stevens Institute of Technology, University of Missouri, Oklahoma A & M, University of California at Berkeley, University of Houston and University of Oklahoma.

A. J. Liebman New Head Of Coatings Committee

A. J. Liebman, Dravo Corp., Pittsburgh, has been named chairman of Technical Practices Committee 6 on Protective Coatings. Mr. Liebman also is chairman of TP Sub-Committee 6-B which has just issued its second interim report on Surface Preparation of Steels for Organic and Other Coatings.

M. J. Olive to Speak

"Gas Production and Transmission Corrosion Problems" is the topic of a scheduled address by M. L. Olive of Arkansas-Louisiana Gas Co., Shreveport, La., before Teche Section May 13 at Lafayette. Films were scheduled to be shown also.

Bronze Rod Film

A 30-minute, full color, sound slide film in 35 mm size showing continuous casting of bronze rod, tubes and shapes has been completed by the Continuous-Cast Products Dept., American Smelting & Refining Co., Barber, N. J. The film, in two parts of 15 minutes each, describes the history of the process, its engineering details and its results. The second shows typical applications in industry.

It is available for showing by interested technical groups.

The correct address for NACE member Ing. Salvador G. Alvarez is: Apartado Postal 161, Tampico, Tams., Mexico. Through error, Mr. Alvarez' address was incorrectly listed in the NACE Membership Directory. For those who wish to correct their directory, Mr. Alvarez is listed on page 1 in the Alphabetical Section, and on page 48 in the Geographical Section.

•

Technical material from CORROSION has been reprinted recently in Belgian and British publications.

The S. D. DAY Company

Serving the Oil and Gas Industry

Pictured here are some typical applications of coating and wrapping products distributed by S. D. Day Company.

National Distributor

THE RUBEROID COMPANY*

Pipe Line Asbestos Felt

Gulf Coast Distributor

PITTSBURGH COKE & CHEMICAL CO.*

Hot Applied Coal Tar Enamels for Pipe Lines

Cold Applied Coal Tar Coatings for General Industry

Gulf Coast Distributor

AMERICAN COATING & SUPPLY CO.

Field Jointer

Write, wire or telephone for literature, prices and engineering counsel.

*Available from Houston Warehouse Stock.

S. D. DAY COMPANY

1973 WEST GRAY HOUSTON, TEXAS PHONE JU-2431

Alloy Casting Institute Seeks Fundamental Knowledge

Fundamental knowledge on the characteristics of new high strength and high temperature alloy castings will be sought in a 5-year program of research outlined at a recent meeting of the Alloy Casting Institute technical committees. The research will include fundamental investigations of corrosion.

The continuing study of corrosion under pressure and high temperatures at Ohio State University under supervision of M. G. Fontana includes commonly used alloys of the 18-8 variety (CF-8 and CF-8M) and high nickel grades. Modifications of these alloys will be studied to develop improved corrosion resistance. Preliminary results indicate the feasibility of using small amounts of inhibiting agents in fluids being processed. A paper on this subject, Corrosion by Aqueous Solutions at Elevated Temperatures and pressures, by F. H. Beck and M. G. Fontana was presented at the Chicago NACE Conference in March.

LC Steel Demand Grows

Use of low carbon stainless steels of chemical compositions similar to cast corrosion resistant grades at temperatures in the 1000 to 1600 degree F range has resulted in a demand for castings for this service.

Batelle Memorial Institute will conduct investigations into the mechanical properties of cast steels for jet engine service. Information indicates cast alloys of the higher carbon, heat resistant types probably have better mechanical properties in the 1000-1600 degree F range than low carbon corrosion resistant grades but other considerations may make it necessary to modify the materials. Special alloys for jet engine use may be the ultimate outcome.

Batelle also is investigating the development of alloys suitable for service above the 2000-2100 degree F range, to provide either mechanical, or corrosion resistant properties superior to present alloys, or to secure equivalent performance with alloys containing smaller proportions of strategic materials.

Studies also are contemplated into the high temperature strength properties of alloys not too widely used now but which may be substituted for alloys of higher nickel content.

Effect of "Tramp" Elements

What effect "tramp" elements have on the corrosion resistance, heat resistance and foundry characteristics of cast high alloys also will be probed. Because of the limited amount of primary alloying metals available it is necessary for alloyers to use maximum quantities of purchased scrap. Because scrap not only is in short supply, but also because it is improperly segregated, contaminating elements such as copper, tungsten, lead, tin, antimony, zinc, aluminum, arsenic, cadmium and others find their way into the cast materials. The investigation will seek to determine the maximum amounts of these unwanted metals which can be tolerated in castings for specific applications.

First to be studied is 18-8 LC (CF-8) and 18-8 molybdenum (CF-8M) corrosion resistant types. The investigation will be confined at the outset to the HT grade, and will include thermal fatigue and hot tensile tests at 1600 degrees F.

High Strength Alloys

Cast alloys having the corrosion resistance of the 18-8 types but with higher strength than is obtainable in these grades also will be sought. Objectives are to develop materials with two basic types of mechanical properties: 1) A cast material having minimum yield strength of 100,000 psi and 10 percent minimum elongation. 2) A hardenable cast material providing a minimum of 350 Brinell hardness with 5 percent minimum elongation.

Because results obtained in a specific corrosion test are not always indicative of the results which will be obtained with another material or another set of conditions, the institute is seeking fundamental information on the corrosion behavior of materials so the action of various corrodents under varying conditions will be understood more clearly. This investigation, also under Dr. Fontana at Ohio State University, after an initial literature survey, will consider first cast high alloy grade CF-8.

A second basic research program will involve studies on the relationship, if any, between magnetic and corrosion-resistant properties of the CF-8 grade. Preliminary investigations based on nitric acid tests show no difference in corrosion resistance between the magnetic and non-magnetic varieties, but other media will be studied to see if these results are of general application.

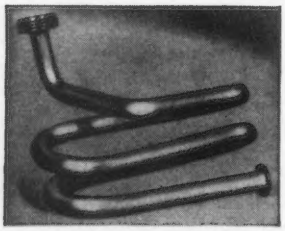
STOP CORROSION LOSSES...

Caused by Sulfuric, Nitric, Phosphoric Acids

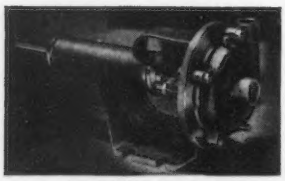
Specify parts made of

ILLIUM

. . . the corrosion, erosion and heat resistant alloy



Shown above is ILLIUM welded tubing. This small-diameter tubing is easily bent and flared to exact tolerances. It may be welded to itself or other metals, and retains its bright finish in service.



The ILLIUM Utility Pump
A rugged pump designed for laboratory, pilot plant, and small industrial applications. Made entirely of ILLIUM, it will not contaminate material being pumped, and will often outlast stainless steel pumps as much as 5 times. Write for catalog information.

Critical processing operations involving corrosive liquids and gases have proved Illium's ability to slash replacement and maintenance costs down to a minimum.

Unequalled in resistance to attack by all concentrations of sulfuric acid, at virtually all temperatures, Illium is similarly well-suited to handling nitric, phosphoric, and mixed acids, and many acid-salt solutions. Over the years, it has firmly established its superiority over other alloys in the chemical, drug, petroleum, and food industries.

Available in castings up to 575 lbs., Illium is easily machined and welded. Samples for testing and investigation will be sent on request.

Write for Bulletin 651 for complete data.

THE ILLIUM CORPORATION, FREEPORT, ILLINOIS

Makers of Special Alloys and Quality Castings for Industry

ASTM to Hear Papers Of Corrosion Interest

Among the technical papers to be given at the 56th annual meeting of the American Society for Testing Materials June 28-July 3, inclusive at Atlantic City are the following:

Some Examples of the Functional Use of Glass as a Coating for Steel, G. H. Spencer-Strong, Pemco Corp.

Chemical Resistance of Glassed-Steel Process Equipment, O. J. Britton and E. A. Sanford, The Pfaudler Co.

Acid Resisting Properties of Porcelain Enamels, Harold C. Wilson, Vitreous Steel Products Co.

Resistance of Porcelain Enamels to Weathering, Dwight G. Moore, National Bureau of Standards.

Analysis of the Expected Benefits Resulting from the Application of Coatings to High Temperature Components of a Jet Engine, Allen C. Francisco, NACA-Lewis Flight Propulsion Lab.

High Temperature Ceramic Coatings as Applied to Aircraft Power Plants, B. L. Paris, Wright Air Development Center.

A Laboratory Evaluation of Ceramic Coatings for High Temperature Applications, Sara J. Ketcham, Naval Air Material Center.

•

The cost of advertising in CORROSION per thousand readers has diminished each year since the magazine was founded.

Marine and Titanium Corrosion Papers to Be Heard on Program

Papers on marine and titanium corrosion for delivery at The Electrochemical Society's 104th meeting at Wrightsville Beach, N. C. September 13-16, 1953 are being accepted. Authors are requested to submit abstracts of not more than 75 words to the secretary of the society, 235 West 102nd St., New York 25, N. Y. not later than July 1.

Corrosion sessions will be held on September 16, coinciding with the first day of the annual meeting of the Sea Horse Institute, replacing the usual informal sessions of the institute on that date.

An opportunity to inspect some of the International Nickel Company's marine-exposure facilities will be provided and F. L. LaQue, of Inco's Corrosion Engineering Division, is planning an exhibition of corroded samples.

A $7 fee will permit attendance at all sessions of the society's meeting the first half of the week and of the institute the second half. Wednesday only a special $5 fee for Sea Horse Institute personnel will permit them to attend the corrosion sessions of the society and the sessions of the institute.

Maitland Succeeds to TP-6B Chairmanship

B. B. Reinitz has resigned as chairman of Technical Practices Sub Committee No. 16B, "Corrosion of Lead and Other Metallic Sheaths." T. J. Maitland who was co-chairman, will replace him. Mr. Reinitz, with the Okonite-Callender Cable Co., Inc., Patterson, N. J. said his work on various important company projects made it impossible for him to continue as committee chairman.

Mr. Reinitz is the author of "Cable Sheath Corrosion and Prevention," a technical paper presented at the 1953 NACE Conference.

Bilhartz Accepts Post On Program Committee

H. L. Bilhartz, with The Atlantic Refining Co., Dallas, has accepted the co-chairmanship of the 1954 Conference Technical Program Committee. The conference will be held at Kansas City March 15-19. F. L. Whitney, Jr., Monsanto Chemical Co., St. Louis, is technical program chairman. Under the ordinary course of events Mr. Bilhartz will be technical program chairman for the 1955 conference, now scheduled to be held at Chicago early in March.

Pittsburgh Section

A buffet luncheon was cheduled to start proceedings for the May 7 Pittsburgh Section meeting in the conference room of the Mellon Institute, Pittsburgh. "Corrosion of Radiant Heating Systems," by Richard H. Peifer, comprised the technical program, according to Section chairman N. P. Peifer.

International Group to Convene at Stockholm

The fifth annual meeting of the International Committee of Electrochemical Dynamics and Kinetics will be held at Stockholm, Sweden, July 25-28, 1953, immediately before the International Congress of Pure and Applied Chemistry.

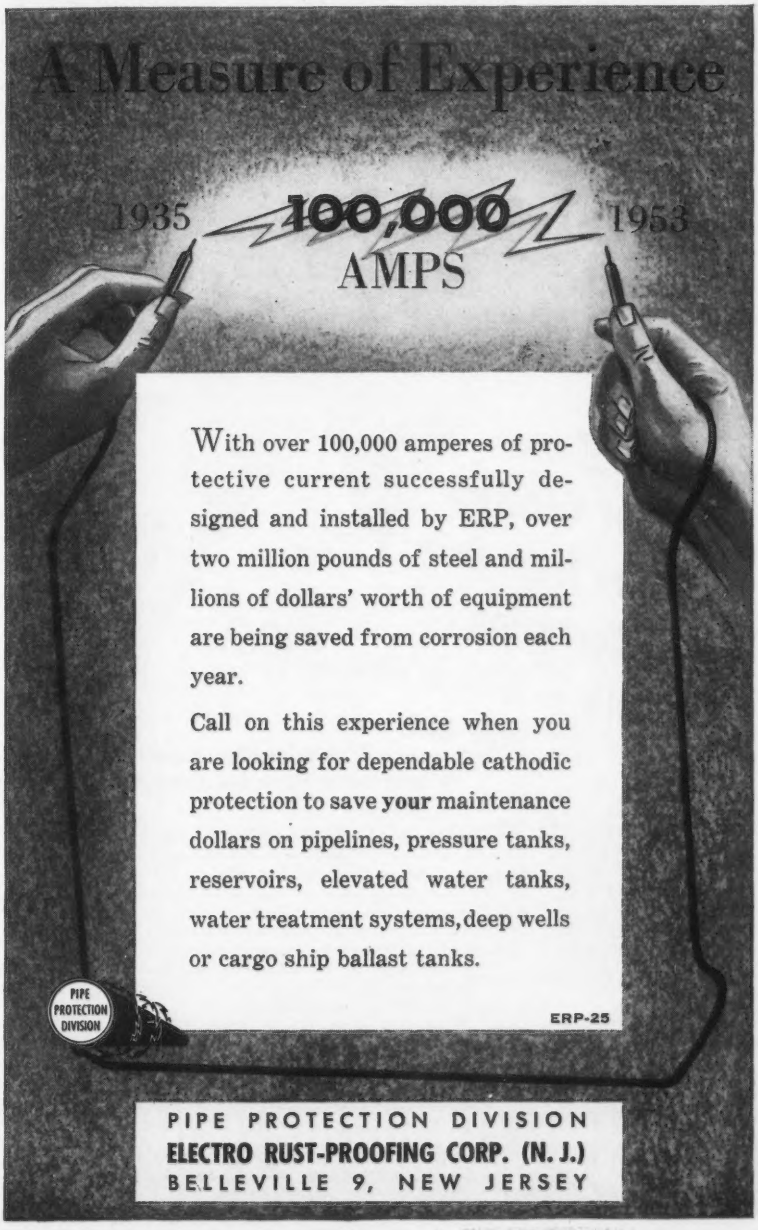
Scheduled on the program are papers on the following topics:

1. Fundamentals—electrochemical nomenclature and definitions
2. Experimental methods in electrochemistry
3. Electrochemical behavior of metals and non-metals
   - 3.1 Potential-pH diagrams (equilibrium diagrams and practical diagrams)
   - 3.2 Polarization curves
   - 3.3 Miscellaneous
4. Applications to corrosion
5. Electrolytic phenomena
6. Applications to general and analytical chemistry
7. Miscellaneous.

Additional information concerning the organization and the meeting may be obtained from the Secretary-General Marcel Pourbaix, University of Brussels, Belgium; from the secretary for Sweden, Uno Tragardh, Royal Institute of Technology, Stockholm, or from the president of the CITCE, Pierre Van Rysselberghe, University of Oregon, Eugene, Oregon.

•

In each December issue of Corrosion there is published a tabular cross-indexed reference to all technical material published in the preceding 12 months. This table includes a chronological list of papers and authors by page numbers and an alphabetical list of authors.


A Measure of Experience
1935
100,000
AMPS
1953
With over 100,000 amperes of protective current successfully designed and installed by ERP, over two million pounds of steel and millions of dollars' worth of equipment are being saved from corrosion each year.
Call on this experience when you are looking for dependable cathodic protection to save your maintenance dollars on pipelines, pressure tanks, reservoirs, elevated water tanks, water treatment systems, deep wells or cargo ship ballast tanks.
PIPE PROTECTION DIVISION
ERP-25
PIPE PROTECTION DIVISION
ELECTRO RUST-PROOFING CORP. (N. J.)
BELLEVILLE 9, NEW JERSEY

'54 Kansas City Technical Program Is Outlined

Nine Symposia and Other Features Are Listed by Whitney

Nine symposia titles, two round tables and three other possible subjects for symposia to be given during the Tenth Annual Conference and Exhibition of the National Association of Corrosion Engineers have been revealed by F. L. Whitney, Jr., Technical Program Chairman. The conference will be held in Kansas City on March 15-19, 1954.

Mr. Whitney also named several of the persons who have assumed responsibility for the presentation of symposia. H. L. Bilhartz, Atlantic Refining Co., Dallas, has accepted the post of technical program co-chairman and, in the ordinary course of events, will be the technical program chairman for the NACE conference in 1955, now scheduled to be held in Chicago.

Other Elements Set Up

The sessions devoted to pipe line coatings and to pipe line group discussions will be held again at Kansas City as they were at the Chicago conference in March, 1953. These meetings were conspicuously successful, Mr. Whitney said, and it was planned that they be repeated in 1954. Mr. Whitney said also that educational lectures will be given in 1954 as they were in Chicago this year. These lectures were especially well attended.

Symposia Listed

The following symposia are scheduled definitely. Where assigned the names of pertinent symposium officials have been included.

Cathodic Protection Symposium.

Chemical Industry Symposium—E. G. Holmberg, Alloy Steel Products Co., Linden, N. J., chairman.

Corrosion Principles Symposium—H. P. Godard, Aluminium Laboratories, Ltd., Kingston Ontario, chairman.

Power and Communication Industry Symposium—R. M. Lawall, American Telephone and Telegraph Co., Cleveland, chairman.

Elevated Temperature Corrosion Symposium—G. A. Fritzlen, Haynes Stellite Division, Union Carbide & Carbon Corp., Kokomo, Ind., chairman; E. N. Skinner, The International Nickel Co., Inc., New York City, co-chairman.

Oil and Gas Production Symposium—R. C. Buchan, Humble Oil and Refining Co., Houston, chairman.

Protective Coatings Symposium—N. K. Senatoroff, Southern Counties Gas Co., Los Angeles, Cal., chairman.

Refinery Industry Symposium—E. H. Tandy, Standard Oil Company of Cal., El Segundo, Cal., chairman.

Round Table Discussions

Round table discussions will be held as follows:

Pipe line and Underground Corrosion.

General Corrosion Problems—L. E. Stout, Washington University St. Louis, chairman.

Other symposia being considered are: Non-Destructive Testing, Corrosion by Atmospheric Pollutants and Cost of Corrosion.

Educational lectures will be under the supervision of R. C. Weast, Case Institute of Technology, Cleveland, chairman.

Mr. Whitney said he will welcome assistance and suggestions concerning other possible symposia and for papers to be presented in those outlined. Where a technical program chairman has been named, Mr. Whitney suggests the title of the proposed paper, together with a summary, be sent to him. Where none has been named, the information may be addressed to Mr. Whitney, whose address is: Monsanto Chemical Co., 1700 S. Second St., St. Louis 4, Mo.

Save Your Concrete Floors from Drip Corrosion . . . with Phenoline 300 you can . . .
● Protect New Concrete
● Resurface or Repair Old, Corroded Concrete
Mixed with silica sand or mica fillers, Phenoline 300 makes an effective inexpensive barrier against acids, alkalies and organic solvents that drip or spill on concrete floors. Trowels in any thickness to a slip-proof finish even when wet. Does not need a primer. Apply Phenoline 300 to any neutral or alkaline surface such as concrete or transite. The powerful bond is unaffected by normal traffic, time or temperature.
Phenoline 300 is unaffected by hot caustics up to 70% in concentration, most hot, dilute acids and hot salt solutions.
Bulletin A-50 tells how you can corrosion-proof your concrete. Write for it today.
CARBOLINE
CARBOLINE COMPANY
333 Thornton Avenue • St. Louis 19, Mo.
Specialists in Corrosion Resisting Synthetic Materials

Liebman Wins Prize For Technical Paper

A. J. Liebman, Dravo Corp., Pittsburgh, chairman of Technical Practices Committee 6 on Protective Coatings and Chairman of Technical Practices Sub-Committee 6G on Surface Preparation for Organic Coatings, has been given a prize by his company for preparation and presentation of a technical paper. Mr. Liebman, who is assistant director of the Dravo research department, received a second prize of $300 for his paper "Selection of Surface Preparations and Pretreatments."

First prize awarded by the company went to R. H. Klucher, engineer in the Dravo construction department, machinery division, and several other prizes went to other employees who prepared and presented technical papers. In all, $1200 in prizes was awarded to nine winners.

Sline Heads TP-6B

L. L. Sline of Sline Industrial Painters, Houston, has been named chairman of Technical Practice Sub-Committee 6B on Protective Coatings for Resistance to Atmospheric Corrosion. Horace C. Dick, Products Research Service, Westwego, La., has been named vice-chairman.

DuPont Fellowships

A new program of fellowships to assist and advance the teaching of chemistry in American colleges and universities will be started by E. I. DuPont de Nemours & Co. in the fall. New fellowships will be given 32 institutions for the next academic year.

Economic Research Books

After April 1 Princeton University Press will publish the new books of the National Bureau of Economic Research.

Orientation of Monel Metal Crystals Can Be Determined With Polarized Light*

Figure 1—Photomicrographs (x 50) of 70 nickel-30 copper alloy (Monel) made with polarized light in a recent National Bureau of Standards investigation. Top and bottom photomicrographs were made after the first and second polishing treatments respectively. The close similarity of the shadings of the individual crystals indicates that the apparent optical anisotropy is reproducible. The bureau's study shows that the orientation of Monel crystals can be correlated with extinctions of polarized light.

KNOWLEDGE of the orientation of crystals of metals is often of practical importance, but no generally satisfactory method has been available for determining the orientation of the small crystals found in commercial metals. Because of the need for such a method, the National Bureau of Standards is investigating the possibility of estimating crystal orientation from measurements of changes in the characteristics of polarized light. The work is being conducted by H. C. Vacher of the Bureau's mechanical metallurgy laboratory. Results so far indicate that, in the case of the industrially important alloy of 70 nickel and 30 copper (Monel), crystal orientation can be correlated with extinctions of polarized light.

Commercial metals are composed of aggregates of small crystals or grains. The magnitude of many important properties—such as strength, elasticity and magnetism—differs in different directions in these small crystals. In some specimens of some metals the orientations of the individual crystals do not follow a random distribution; instead, a "preferred orientation" predominates and

(Continued on Page 10)

* For further details see "A correlation of Polarized Light Extinctions with Orientation in 70 Nickel-30 Copper Alloy," by H. C. Vacher. *J. Res. NBS*, 49, 149 (1952) Sept. Reprinted as NBS Res. Paper 2351, 10 cents, Superintendent of Documents, Government Printing Office, Washington 25, D. C.

Chromium Chemical Technical Publications

Available from Mutual

CORROSION CONTROL

No. 34—Corrosion Control in the Refrigeration Industry—16 pages

No. 31—Chromate Corrosion Inhibitors in Brine Systems—8 pages

No. 36—Chromate Corrosion Inhibitors in Chloride Systems—10 pages

No. 35—Corrosion Control in Air Conditioning—16 pages

No. 46—Chromate Corrosion Inhibitors in Air Conditioning Waters—4 pages

No. 39—Chromate Corrosion Control for Engine-Jacket Water—8 pages

No. 55—Corrosion Inhibition with Chromate —Oil and Gas Industries—16 pages

No. 53—Corrosion Inhibitors in recirculating water systems—8 pages

No. 37—Corrosion Criteria—Their Visual Evaluation—8 pages

No. 30—Chromate Corrosion Inhibitors in Bimetallic Systems—12 pages

MUTUAL CHEMICAL CO. OF AMERICA — NEW YORK N.Y. — SINCE 1845

MUTUAL CHEMICAL COMPANY OF AMERICA

Mutual Chromium Chemicals

270 MADISON AVENUE, NEW YORK 16, N. Y.

Plants: Baltimore . . . Jersey City

Tnemec has been killing rust and corrosion for 32 years—

Do you know how?

We Will Gladly Send You Complete details on Request—Write on your letterhead to:

TNEMEC COMPANY, INC.
139 W. 23rd Street
North Kansas City, Missouri

Metal Crystal–

(Continued from Page 9)

the overall properties of the metal vary with direction. Also, the orientations of adjacent crystals influence their interactions when the aggregate is subjected to strain, heat, or corrosive environment.

Diffraction Inapplicable

X-ray diffraction methods of determining crystal orientation have been attempted, but cannot be applied conveniently to small crystals. The metallurgical microscope is convenient for observing small crystals, but its use is generally limited to showing differences in orientation qualitatively. In recent years, these microscopes have been equipped so that the specimen can be illuminated with plane-polarized light. When a metallographically polished and optically active surface is examined with such an arrangement, characteristics of reflected polarized light change measurably from crystal to crystal.

In the commercial metallographic microscope used for the NBS study, the analyzer is fixed in the crossed position with respect to the polarizer, and the light irradiates the polished surface of the specimen at normal incidence. Under these conditions, when an optically anisotropic surface is rotated 360 degrees around the axis of the incident beam, four minima (extinctions) and four maxima will alternately appear in the intensity of the reflected light.

Etching Produces Anisotropy

Although metals having a cubic crystal structure are not inherently optically anisotropic, the surfaces of many such metals—including Monel—become optically anisotropic after etching with conventional metallographic reagents. The angular positions of the polarized-light extinctions of Monel differ for adjacent crystals, and it was found that these positions remained the same after repolishing and re-etching. It seemed to follow that the apparent optical anisotropy, being thus independent of the etching treatment, could probably be correlated with crystal orientation.

Examination of annealed Monel specimens showed clusters of crystals in which each crystal was adjacent to at least one annealing twin. (A twin relationship is indicated in a polished and etched surface when two crystals are separated by a straight line.) It was also observed that some of the clusters contained a crystal whose straight-line boundaries were in four different directions. This made it possible to determine the orientation of that crystal from geometry and a knowledge of the angular relationships of the twinning planes and the coordinate axes of the crystal. In the Monel crystal, the twinning planes and coordinate axes are the four octahedral planes and the three cubic axes respectively. After determination of the orientation of one crystal it was possible to determine the orientations of the twinned crystals. The orientations of 12 crystals were determined and their extinction positions measured.

Polarized light reflected from polished and etched surfaces that were parallel to a cubic plane or an octahedral plane changed but little in intensity with rotation of the specimen. Surfaces of other orientations, however, gave extinctions whose positions could be measured with a fair degree of accuracy. Results showed that one of the four extinctions was near the cubic pole which was inclined to the surface at the smallest angle.

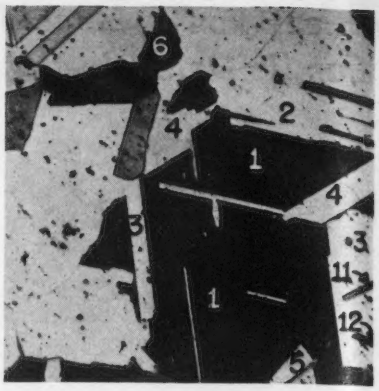


Figure 2—Photomicrograph (x 50) of 70 nickel-30 copper alloy showing 12 crystals whose orientations the bureau was able to determine from the angles between their twin boundaries. Twin boundaries are straight lines and are traces of octahedral planes. The boundaries 1-2, 1-3, 1-4, and 1-5 are the traces of the four octahedral planes in crystal 1.

The NBS study also indicates that the optical anisotropy exhibited by Monel is caused by parallel furrows in the surface and not, as has sometimes been suggested, by a film. The furrows are apparently formed by the tendency of the etching reagent to produce etch pits whose facets are parallel to cubic planes.

REPRINT

Publication 53-1

Surface Preparation Of Steels For Organic and Other Protective Coatings

- **Second Interim Report of NACE Technical Practices Sub-Committee 6-G on Surface Preparation for Organic Coatings.**

This report itemizes the various procedures used to prepare steels for the application of protective coatings. Recommendations as to procedures, standards, safety measures are given. This second report by NACE TP-6G is the culmination of many months of work by committee members. The report has been carefully prepared and checked by committee members with long experience in the coatings application field.

PRICES—Postage Paid

Single Copy $1.00
5 or more Copies to one address, per copy 50c

Address Orders and Make Remittances Payable to

NATIONAL ASSOCIATION OF CORROSION ENGINEERS
1061 M & M Building
Houston 2, Texas

Cuno-Type FKR filter with bonnet removed to show two Ni-Resist cages wrapped with stainless steel wire. Ni-Resist components were cast by THE TAYLOR & FENN COMPANY, Windsor, Conn. The first Flo-Klean filter unit manufactured by the CUNO ENGINEERING CORP., Meriden, Conn., and installed nearly 14 years ago, is still in operation.

CUNO ENGINEERING uses NI-RESIST

BECAUSE No Other Cast Metal Provides Such a Unique Combination of Useful Engineering Properties

NI-RESIST® is a highly nickel-alloyed iron that provides a unique combination of properties at moderate cost . . .

It resists corrosive attacks of *acids, alkalies* and *salts* and is highly resistant to galling and metal-to-metal wear.

Its wear-resistance, combined with inherent resistance to corrosion, makes Ni-Resist ideal for curbing erosion by liquids and slurries.

To these properties add ready machinability, and it is evident why the vital cylindrical cartridge cores of Cuno Flo-Klean Filters are cast in Ni-Resist.

Several types of Ni-Resist are available to meet a variety of industrial demands. Get full information . . . mail coupon now.

At the present time, nickel is available for the production of Ni-Resist and other alloys containing nickel, for end uses in defense and defense supporting industries. The remainder of the supply is available for some civilian applications and governmental stockpiling. There are authorized producers, from coast to coast, equipped to produce Ni-Resist castings in all common forms and shapes.

THE INTERNATIONAL NICKEL COMPANY, INC.
Dept. 20, 67 Wall Street, New York 5, N. Y.

Please send me booklets entitled, "Engineering Properties and Applications of Ni-Resist," and "Buyers' Guide for Ni-Resist Castings."

Name_____ Title_____

Company_____

Address_____

City_____ State_____

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N.Y.

CLEANING, COATING, WRAPPING & RECONDITIONING

★

HOT DOPE

Straight from the Kettle on PIPE PROTECTION

★

By Boyd Mayes

• A gent came out to look over our operation not long ago . . . said he was an economist. We showed him the works, like we're always glad to show anybody through our setup . . . stem to stern. There's no secret about how we do business. He watched every detail with a keen eye . . . cleaning, coating and wrapping of pipe for oil and gas lines. He was a pretty sharp guy, so far as we can judge economists. He asked prices, per foot, on the size we happened to be running at the time, and we told him. "How," he asked, "does the customer know how much thickness of coating you're spraying on and how much overlap of felt they're getting? . . . They can't actually tell once it's covered with the paper wrap." Well, maybe we're sort of biased about our answer. First, we told him, "They're our customer." Secondly, we told him the story our Dad told us when we started to school and asked him what we should study to be . . . "Be anything you want to be," he said, "but be good at it. Even if you turn out to be a thief, be a good one . . . steal a million dollars and retire; don't steal a hog because you'll have to steal one every week, and you'll finally get caught." Actually, the only answer we could give our visiting economist was that "We'd lost customers, but we'd never cheated one!"

MAYES BROS.

1150 McCarty HOUSTON, TEXAS Oil chart 7566

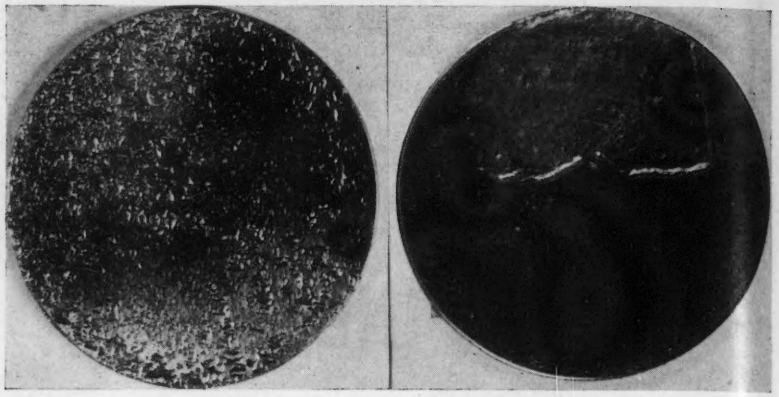


Figure 1—Steel specimens exposed to soil corrosion for two months in the National Bureau of Standards corrosion laboratory. The specimen on the left was exposed to acid soil (pH 2.9), that on the right to alkaline soil (pH 9.5). The bureau's study demonstrates that the rate of corrosion of laboratory specimens can be determined indirectly by electrical measurements, without direct examination or weighing.

*NBS Tests Indicate Corrosion Rate In Soil Is Measurable Electrically**

A RECENT laboratory study by the National Bureau of Standards proves for the first time that the rate of weight loss of a piece of steel corroding normally in soil can be measured electrically, without actually weighing the metal. Conducted by W. J. Schwerdtfeger and O. N. McDorman of the NBS corrosion laboratory, the study gives further evidence that the electrochemical theory of corrosion applies generally to soils. Although the NBS measurements were restricted to the laboratory, the success of the work suggests the possibility of valuable practical applications, such as determination of the corrosion rate of a tank or other underground structure without the need for visual inspection.

When iron or steel is exposed to the soil, local differences in electrical potential develop at the surface of the metal, resulting in the formation of numerous small corrosion cells. This means that electric currents flow through the soil from certain areas (anodes) to areas of less negative potential (cathodes), with accompanying discharge of hydrogen ions at the cathodes and loss of metal from the anodes. By Faraday's law, the rate of weight loss from corrosion is proportional to the current.

Established Relation Used

The NBS-demonstrated measuring technique is based on a relation established by other investigators, who showed that the current in a corrosion cell can be expressed in terms of the values of anodically and cathodically (positively and negatively) applied direct current, from an external source, that will just reduce the cell current (corrosion current) to zero. The relation is

$$i_o = \frac{I_p I_q}{I_p + I_q}$$

where i_o is the corrosion current and I_p and I_q are, respectively, the cathodically and anodically applied currents required to reduce the corrosion current to zero. As increments of current are applied, the potential of the cell changes. When the measured potentials are plotted against the applied currents, a change in the slope of the curves usually marks the points (I_p and I_q) at which the applied currents have reduced the local corrosion current to zero.

The corrosion cells used by previous investigators in confirming the equation experimentally contained separated anodes and cathodes, so that I_p and I_q could be directly measured and the corrosion currents computed therefrom compared with values obtained by direct measurement. However, when a single piece of metal is exposed to a corrosive medium, as in the NBS study, it is obviously impossible to measure these currents directly. Here the corrosion current, made up of innumerable small cell currents, must be determined indirectly, if at all, from changes in slope of the current-potential (polarization) curves. The NBS study demonstrates for the first time that the total corrosion current i_o—and thus the weight loss—of a single piece of metal normally corroding in soils and presumably in other aqueous media, can be determined by the equation, from values of I_p and I_q obtained from the changes in slope of the cathodic and anodic polarization curves.

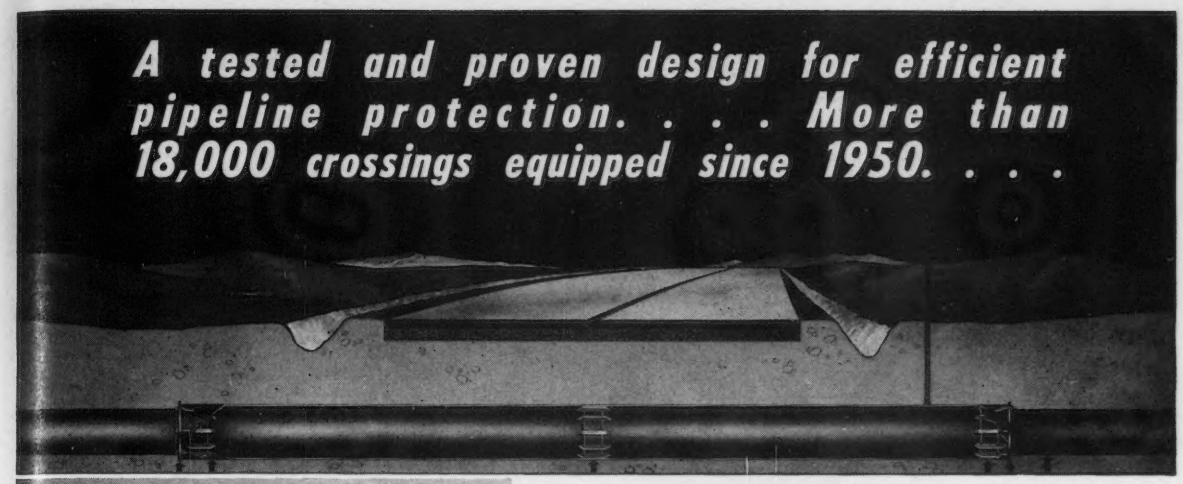
Specimens Exposed Two Months

In establishing the feasibility of the indirect measuring technique, weighed steel specimens, differentially aerated, were exposed at the bureau to five corrosive soils for approximately two months. The soils ranged in reaction from very acid (pH 2.9) to very alkaline (pH 9.6). Because of the possibility of changes in rates of corrosion during the two-month period, polarization curves were obtained at intervals throughout

(Continued on Page 14)

* For further details see "Measurement of the Corrosion Rate of a Metal from Its Polarization Characteristics," by W. J. Schwerdtfeger and O. N. McDorman. *J. Electrochem. Soc.*, **99**, 407 (1952) Oct.

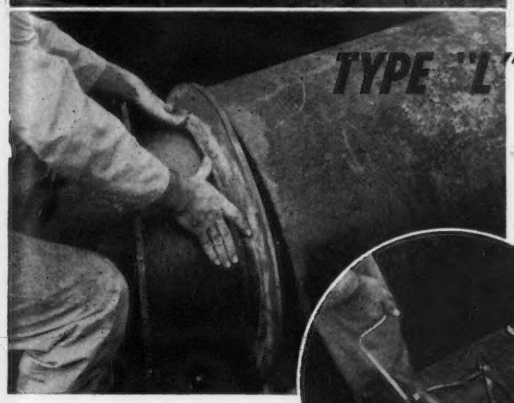
A tested and proven design for efficient pipeline protection. . . . More than 18,000 crossings equipped since 1950. . . .



Williamson

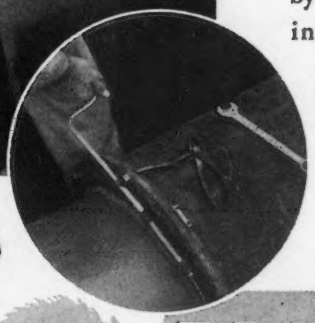
CONCENTRIC-SUPPORT INSULATORS

Provide low-cost, dependable protection for right-of-way crossings . . . Simple to install with a common wrench . . . Impervious to pipe coatings . . . Support blocks center pipe in casing, spacer blocks provide clearance through casing . . . Available for all combinations of pipe and casing diameters.



TYPE "L" WmSEAL CASING BUSHINGS

Provide a water-tight seal even under the worst conditions of out-of-round casing . . . Unaffected by dirt, moisture or backfill during or after installation (no dope, adhesive or shield required) . . . Electrical insulation of pipe from casing provides economical cathodic protection.



Easily installed with common hand tools.

Write for Bulletin 249-A

Visit Us At the IPE—Booths 28-29 Oklahoma Bldg. Tulsa — May 14-23

T. D. Williamson, Inc.

THE PIG WITH THE POKE CLEANS PIPE LINES

P. O. BOX 4038

TULSA 9, OKLAHOMA

REPRESENTATIVES

CANADIAN EQUIPMENT SALES & SERVICE CO., LTD.
EDMONTON, CALGARY, TORONTO, CANADA

PHILIP H. MOORE
DURBAN, NATL, SOUTH AFRICA

LANGLEY Y CIA.
BUENOS AIRES, ARGENTINA

KERR ENGINEERING SALES CO.
PIGS & TAPPING MACHINES
PITTSBURGH 22, PENNSYLVANIA

H. E. DAVIS
LOS ANGELES, CALIF.

STUART STEEL PROTECTION CORP.
BUSHINGS & INSULATORS
KENILWORTH, N. J.

BEN W. BRUNDAGE COMPANY
OAKLAND 11, CALIFORNIA

JAMES S. KONE & CO.
AMARILLO, TEXAS

HAMMOND IRON WORKS
KEYES TANK DIVISION
CASPER, WYOMING
PROVO, UTAH

TOD PAZDRAL
HOUSTON 5, TEXAS

NBS Tests Indicate—

(Continued from Page 12)

the exposure period. At the end of this period the specimens were removed from the soils, cleaned and reweighed. Actual weight losses were compared with weight losses calculated indirectly by Faraday's law, using values of corrosion current (i_o) obtained from the equation on the basis of values of I_p and I_q indicated by changes of slope in the polarization curves. The calculated values of weight loss differed on the average from the actual values by approximately 4 percent.

This technique for indirect electrical measurement of corrosion rate appears to have possibilities for extensive application both in the laboratory and in the field. In laboratory determinations of the corrosion rate of certain materials, for instance, the weight loss resulting from corrosion might actually be exceeded by the cleaning error. The electrical method makes possible much more accurate comparisons of the corrodibilities of such materials. For field determination of underground corrosion the electrical method, if it proves practicable in the field as well as the laboratory, would have several advantages in addition to obviating the need for excavating the underground object. Although in some soils ferrous metals corrode at a constant rate year after year, in other soils corrosion gradually slows down and in time may virtually cease. Actual weighing or inspection of an object that has been buried for years will indicate how much total corrosion has occurred, but will not show how rapidly, if at all, it has been corroding just prior to inspection. The electrical method, on the other hand, measures the present corrosion rate, which is likely to be of greater practical interest than the history of past corrosion. Furthermore, the electrical method does not involve the removal of corrosion products, which often inhibit corrosion.

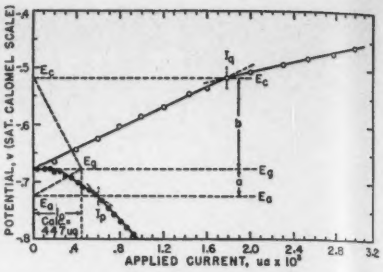


Figure 2—Polarization curves of a steel electrode exposed to a certain soil in the National Bureau of Standards investigation. The curves are typical of ferrous materials corroding in soils. Potentials were measured with an electronic interrupter in conjunction with a potentiometric circuit. Significant changes in slope of the curves occur at values of applied current I_p and I_q. After the value of the corrosion current i_o has been calculated from I_p and I_q, the triangle connecting points E_c, E_g, and E_a can be completed. The line E_c-E_g then represents the hypothetical polarization of all the cathodic elements, and the line E_a-E_g applies similarly to the anodic elements; these lines show whether the reaction is cathodically or anodically controlled. The current I_p is the value required to prevent corrosion, commonly known as the current needed for cathodic protection. This current was found at NBS to bear a relatively fixed relation to the corrosion current i_o, so that the latter can be estimated from the former.

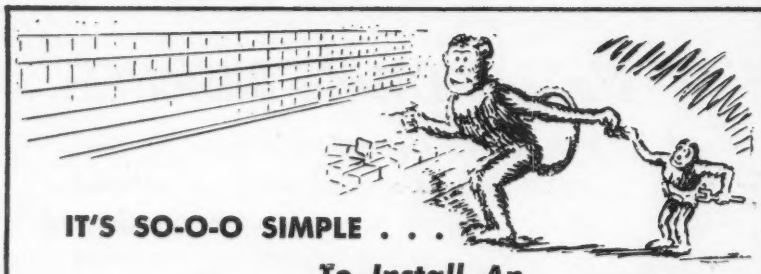
NACE Is Looking For a Copy of Soil Corrosion and Pipe Line Protection

By SCOTT P. EWING

This book was published by the American Gas Association in 1938, and the NACE Central Office wants a copy for the library. In exchange for a copy of Mr. Ewing's book, the Central Office will give any one of the following:

Cathodic Protection—A Symposium
Bibliographic Survey of Corrosion—1945
Bibliographic Survey of Corrosion—1946-47.

Anyone wishing to exchange a copy of the Ewing book, please contact A. B. Campbell, National Association of Corrosion Engineers, 1061 M & M Building, Houston 1, Tex.



IT'S SO-O-O SIMPLE . . .

To Install An

INSULATED GASKET UNION

The Insulator You Have Been Searching For!

- Metal to Metal Threads
- Perfect Electrical Insulation
- 300# W. O. G.
- Will Not Break
- All Insulating Parts in Compression
- No Field Education Required
- Electrically and Pressure Tested

Sizes ½" - 3" Inclusive

SERVICE ENGINEERS, INC.
Manufacturers of Industrial Plastic Products
3030 W. Pafford P. O. Box 11068 Fort Worth 9, Texas

Inter Society Committee CORROSION MEETINGS CALENDAR

June 4-6—Protective Coatings Division Meeting, Annual Chemical Institute of Canada, Conference, Windsor, Ont.

June 15-18—American Electroplaters Society, Annual Meeting, Philadelphia. Benjamin Franklin Hotel. (Some papers on corrosion.)

July 20-25—AAAS Gordon Research Conference on Corrosion, New London, N. H.

August—Symposium on Corrosion, Association Committee on Corrosion Research and Prevention of National Research Council of Canada.

Sept. 13-17—The Electro-chemical Society, Fall Meeting, Wrightsville Beach, N. C., Ocean Terrace Hotel.

•

Of the editorial material published in CORROSION in 1952, 77 percent was of reference value.

LOWER MAINTENANCE COSTS

LESS PLANT "DOWN-TIME"

LESS SOLUTION LOSS

• When you use versatile Tygon Plastics to protect buildings, tanks, ducts, pipe, valves, pumps and other equipment from corrosive attack, you're not only sure of longer, maintenance-free life, but: 1. You reduce "Down-time" resulting from taking equipment out of production for repairs or replacement, and 2. You avoid product or solution loss from corrosive contamination.

• Tygon Plastics are resistant to a wider range of chemicals than any other material of construction, with the exception of glass and chemical stoneware. Yet, Tygon Plastics have a versatility in use approached by no other material.

For example: Tygon sheet linings 3/32" thick can be applied to tanks, ducts, pipe and valves from 2" dia. up. Tygon cut or molded gaskets provide pressure tight, corrosion-resistant seals; Tygon molded mechanical goods items can be made to virtually any shape and in a wide range of hardnesses; Tygon flexible Tubing makes an excellent piping medium for gas, air or liquids, and Tygon extruded strips, tape or special cross-sections solve difficult sealing and insulation problems.

The same basic Tygon sheet stocks, liquefied to form a paint, provide unexcelled protection for tank exteriors, machinery, walls, structural steel, in fact for any surface where corrosive attacks from fumes, condensates or spillage may occur.

Tygon Plastics bring to the corrosion engineer, a versatile, flexible, effective material for saving maintenance dollars. If you're not acquainted with Tygon Plastics, drop us a note, today.

PROCESS EQUIPMENT DIVISION . . .

U. S. STONEWARE

Since 1865 • Akron, Ohio

NEW PRODUCTS —Materials—Service—Literature

Pneu-Pump, a low volume pneumatic ejector with a ball valve as the only moving part can be used to pump abrasive liquids, acids, alkalis, brine, mud, molten metals and salts, sludges, slurries, and many other materials. Manufactured by Yeomans Brothers Company, 1999 North Ruby St., Melrose Park, Illinois, they are made in various sizes and shapes, lead lined, of stoneware, and rubber lined. They can be operated by compressed air or by steam by means of a simple auxiliary apparatus.

•

Nylon and Teflon rod, strip, tubing and slabs are being provided by Polymer Corp. of Pennsylvania, Reading, for fabrication by machining. Machined nylon parts are replacing metal frequently in corrosive environments.

•

A Corrosion Chart published by Wolverine Tube Div., of Calumet & Hecla, Inc., 1850 Guardian Bldg., Detroit 26, Mich. lists general information on the corrosivity of copper, copper alloys, aluminums and some other metals to several hundred acids, chemicals, foodstuffs, gases, oils and waters. Copies of the chart are available on request. Data on Wolverine Trufin, an integral finned tube available with 5, 7, 9, 11 and 19 fins per inch in copper and aluminum, and in bimetallic arrangements in standard sizes and inside diameters is given in Data Sheets 651-A, B and C. Data sheet 651-D describes application of Trufin to water cooled Freon-12 condensers. Report No. 4 on "Condensation of Vapors on Finned Tubes Having 19 Fins per Inch" describes the heat transfer efficiency of this specification of tube. The company's extensive inquiries into the performance of its tubes makes it possible for them to prescribe accurately quantities and equipment for specialized needs. A report by the Engineering Research Institute of University of Michigan, January, 1951 on "Performance of Finned Tubes in Shell and Tube Heat Exchangers" exhaustively surveys this problem and supplies results of inquiries in tabular and graphic form.

•

Slipicone, a silicone compound manufactured by Dow Corning Corp., Midland, Mich. is used to coat materials to prevent organic materials from adhering to them. The film will not melt or harden even after long exposure to temperatures ranging from —40 to 400 degrees F. Used on kettles, coils and filters, the material makes possible a substantial saving in cleaning time, manufacturers say. It is water repellent and insoluble in water, contains no solvent, and preferentially wets and adheres to metal, glass and ceramic surfaces.

•

Ultraviolet light is being used as a catalytic agent in such reactions as halogenation, oxidation, hydrolysis, polymerization and isomeric transformation. Hanovia Chemical and Manufacturing Co. makes an ultraviolet light lamp with a quartz surface for the immersion well assembly which reaches temperatures up to 1450 degrees F. The lamp is designed to resist corrosion by chlorine, hydrogen chloride and other agents.

•

Practical Nickel Plating, Bulletin No. 77, a 44-page illustrated booklet with tables and charts provides the designer, specifying engineers and user with basic information of electroplating and nickel plating. Copies may be obtained from The International Nickel Co., Inc., 67 Wall St., New York City.

•

An-Drite, a new chemically treated gelatinous aluminum oxide hydrate in the form of ⅛-inch diameter spheres, is said by its manufacturer, Ansul Chemical Company, Marinette, Wis. to be more efficient in eliminating moisture from refrigeration systems than other desiccants. The material is supplied in a special container for attachment to lines. It also is adaptable to dehydrating other gas systems.

•

Stainless Steel shapes, rings, forgings, bars and other items are described and illustrated in a 4-page folder available from G. O. Carlson, Inc., Thorndale, Pa.

•

Kontol 77, a new oil soluble organic corrosion inhibitor has been developed by Tretolite Company, St. Louis 19, Mo. It was developed to provide protection against acidic components found in crude oils and against rusting by oxygen in finished petroleum products. Only 3 ppm Kontol 77 prevented rusting by aviation grade gasolines using ASTM Test D-665. Designed to have no adverse effect on high quality petroleum products, 14 ppm of the material in 100/130 octane gasoline makes no noticeable changes in the gasoline.

•

Stellite alloy balls and seats are used in sub-surface oil well pumps handling corrosive and abrasive fluids. Their use is described in Haynes Alloys Digest, Vol. 4, No. 4, April, 1953.

•

Rodine pickling acid inhibitors are described in a 4-page illustrated folder available from American Chemical Paint Co., Ambler, Pa.

•

Lebanon Steel Foundry, Lebanon, Pa. has opened an office at 304 Crescent Bldg., 1411 Crescent St., Montreal, Quebec.

•

NeoCoat, a liquid Neoprene coating which may be applied by brush, spray or dip is recommended by its manufacturers, Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia 7, Pa. for use in heavily contaminated industrial environments. The material, which cures to a live, air-cured rubber is not a water dispersion and is suggested for use on the exteriors of surfaces exposed to corrosive fumes, splashing and spillage. It is weather resistant, easily repaired, and cures in air without accelerator or heat.

•

Haynes Alloy No. 25 sheet, cold-rolled to thicknesses as thin as 0.0001-inch, has excellent strength and hardness and good corrosion resistance. The cobalt base alloy is now available with a wide range of hardness values, optimum hardness being obtained at a cold-reduction of about 40 percent. Hardnesses up to Rockwell C-55 have been produced by 50 percent reduction followed by an ageing heat treatment. The alloy in thin sections is used for various industrial purposes, such as deflectors to prevent hot spots on turbine blades, spring blades for high-temperature switching devices and as diaphragms in ramjets.

•

Clepco-Glorod Series W immersion heaters for use in alkaline baths are being made by Cleveland Process Co., Cleveland, Ohio. The nickel alloy resistance element is covered by a quartz body and a sealed, vapor-proof junction box prevents entrance of liquids and vapors, manufacturers say. They are available in dual voltage, 230-460 v single phase in capacities from 1000 to 6000 watts by thousand watt increments and in 10,000 watts.

•

Corrosion Engineers or maintenance men are invited to apply for attendance at one of a series of courses of instruction on plastic materials of construction to be given during the summer of 1953 by Atlas Mineral Products Co., Mertztown, Pa. No fee will be charged for the courses but students must defray traveling and living expenses. Attendance is limited to male industrial engineers and maintenance men who require knowledge of corrosion resistant coatings, linings, jointing materials, fabricated plastics and caulking materials. Those who wish to attend one of the courses are invited to write to Joseph A. Snook, vice-president, Atlas Mineral Products Co., Mertztown, Pa. giving dates of three alternate weeks during which they can attend.

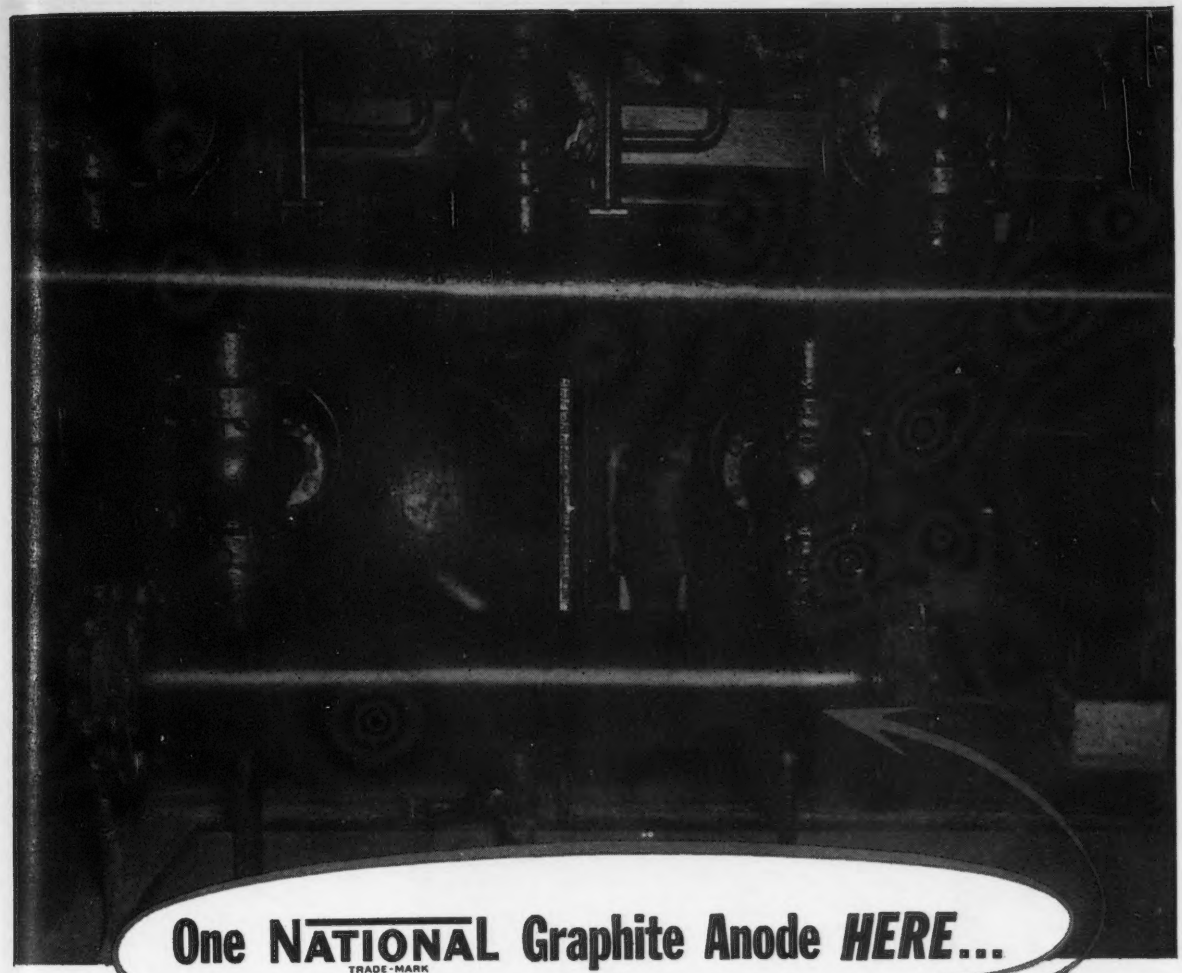
•

Graycote, a plastic sealing compound manufactured by Chicago Gasket Company, 1275 W. North Ave., Chicago 22, Ill. is recommended for application to threaded joint surfaces, and for application to gaskets, to prevent leakage of a large number of materials. The compound is insoluble in most hydrocarbon liquids, ammonia, dilute acids and other aqueous and chemical solutions, the manufacturers say. It is nonseizing.

•

Nubelon S, is a silicone base resin finish with many of the surface hardness and durable qualities of porcelain enamel but without its brittleness, has been announced by the Glidden Company, Cleveland, Ohio. The new material, a baking enamel curing at 425 degrees F, is flexible enough to offer the possibility of application before fabrication, is resistant to dyes, shows no appreciable attack when exposed to fog tests of 20 percent salt water solution at 95 degrees F for 4000 hours and is resistant to crude tall oil, carbon tetrachloride, formaldehyde, 63 percent ammonium nitrate and 2 ethyl hexoic acid.

(Continued on Page 18)



One NATIONAL Graphite Anode *HERE*...

TRADE-MARK

Prevents CORROSION in 4500 Sq. Ft. of CONDENSER TUBING

● If you think of cathodic protection exclusively in relation to buried or submerged structures, take a tip from this system designed by Leib-Jackson for City Products Corporation's Federal Cold Storage plant in Kansas City, Kansas.

Here, a single "National" electrode, tied into 12 enclosed multi-pass ammonia condenser units, protects almost two miles of 2″ tubing against the corrosive action of water rich in CO_2.

In a similar installation involving condenser water of high sulphur content, tube life was increased *five times.*

If your corroding metal is in contact with soil or water, consult one of the many engineering firms specializing in corrosion-control by impressed current, using graphite ground anodes, or write directly to NATIONAL CARBON COMPANY for more information.

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

IN CANADA: National Carbon Limited, Montreal, Toronto, Winnipeg

OTHER NATIONAL CARBON PRODUCTS

● Send for Catalog Section S-6510

HEAT EXCHANGERS • PUMPS • VALVES • PIPING • TOWERS • TOWER PACKING • SULPHURIC ACID CUTTERS
HYDROCHLORIC ACID ABSORBERS • STRUCTURAL CARBON • BUBBLE CAPS • BRICK • GRAPHITE ANODES • BRUSHES

Saran rubber CAN'T rust... CAN'T corrode

that's why
leading engineers choose
MPC SARAN RUBBER* LINED
STEEL PIPE
wherever corrosion is a problem!

You can be sure you're getting the highest degree of resistance to corrosive chemicals, oils, acids and solvents when MPC SARAN RUBBER-LINED STEEL PIPE is specified. Available in either fabricated light gauge steel or standard steel pipe in 10' and 20' standard lengths, ranging in size from 8" up . . . or fabricated to your exact requirements. Fittings in standard and special designs for all diameters.

For additional information write today to your nearest MPC representative or to our application engineering department.

You can lick corrosion. It's as easy as MPC!

*a development of
The Dow Chemical
Company

EST. mpc 1869

MICHIGAN PIPE COMPANY
Bay City • Michigan

Manufacturers of Wood-Lined Steel, Saran Rubber-Lined Steel, Stainless Steel and Monel Pipe and Fittings. Represented nationally by Saran Lined Pipe Co., Detroit, (Ferndale) Michigan.

NEW PRODUCTS—*Materials—Service—Literature*

(Continued from Page 16)

Porous polychlorotrifluoroethylene filters are being made by Porous Plastic Filter Co., 30 Sea Cliff Ave., Glen Cove, N. Y. The material, trade-named Kel-F by The Kellogg Company, is suitable for filtering strong acids, oxidizing agents, hydrogen peroxide and strong caustics.

•

Jettisonable fuel tanks manufactured by Patushin Aviation Corp., 1418 North Highland Ave., Los Angeles 28, Cal. are cleaned, rinsed, coated with Alodine 600, rinsed again, acidulated rinsed and dried by convection currents in five minutes on a new conveyor dipping system.

•

Feon chemical resistant coveralls are made of Vinyon-N fabric, and are not affected by concentrated mineral acids and alkalis, the manufacturers, Filtration Engineers, Inc., 155 Oraton St., Newark 4, N. J., claim. The material also has high resistance to a wide variety of inorganic acids, bases and salts and is immune to bacteria and mildew.

•

Waste Pickle Liquor (estimated at more than 600,000,000 gallons yearly in the United States) now can be converted into its useful components by a process invented by Dr. Othmas Ruthner of Vienna, adapted to American engineering standards by Blaw-Knox Company's Chemical Plants Division and known as the Blaw-Knox-Ruthner process. The liquor is concentrated by evaporation, ferrous sulfate reduced to ferrous chloride by adsorption of hydrogen chloride. Precipitated ferrous chloride is removed by centrifugation. Regenerated sulfuric acid is returned to the pickling line, ferrous chloride roasted to produce hydrogen chloride for recycling and iron oxide, produced as a by-product. Cost of facilities to process 10,000 tons of sulfuric acid yearly would be about $500,000.

•

Dixon Sintaloy, Inc., 535 Hope St., Stamford, Conn. a subsidiary of Dixon Crucible Co., Jersey City, N. J. has been formed to produce powdered metal parts of steel, semi-steel and iron alloys as well as non-ferrous alloys.

•

American Double-X Mechanical Joints for use with its 3- to 48-inch mono-cast centrifugal cast iron pipe are described in a catalog available free from American Cast Iron Pipe Co., Birmingham 2, Ala. The 44-page catalog contains standard specifications and other useful information.

•

Penfield Manufacturing Co., Inc., 19 High School Ave., Meriden, Conn. is manufacturing a permanent cartridge demineralizer for supplying up to 10 gallons a minute of high purity water. The mono-column demineralizing method uses a mixed bed of cation and anion resins in a single column. It operates by water pressure alone. The setup includes an electric purity indicator and a flow meter for adjusting the intake flow to the optimum rate for most efficient ion exchange.

•

Two Main Uses of ion exchange in the metals field, concentration of metal in dilute solution and separation of components of mixtures of ions are explained in a 16-page preprint of a talk "Ion Exchange in Hydrometallurgical Processes" by A. B. Mindler and C. F. Paulson of The Permutit Company, 330 West 42nd St., New York 36, N. Y. The talk was presented before the AIMME meeting at Los Angeles February 18, 1953.

•

Freeport Sulphur Company will build a pilot plant to recover nickel and cobalt from a 40 million ton nickel deposit discovered at Moa Bay, Cuba. Moa Bay is about 500 miles from Havana.

•

Erkopon plastic coatings, based on Epon resins, have been developed by Earl Paint Corp., 240 Genesee St., Utica, N. Y. for use on both metal and nonmetal surfaces. Available in both air drying and baking type formulations, they can be applied by brush or spray and are also available in trowel consistency to be used for mild acid service in trenches. While sandblasting of surfaces is recommended, they have given satisfactory service used on hand cleaned surfaces, manufacturers say. Excellent resistance to sun, marine atmospheres, salt and other corrosive environments is claimed.

•

Monsanto Chemical Company's Plastics Division, Springfield, Mass. will open a plant to produce polyethylene in 1955 with a 66 million pound initial capacity. Expansion to add 50 percent to this by 1957 is contemplated. Site of the plant has not been announced.

•

Air-Dried Vinyls, baked straight and modified phenolics, catalyzed phenolics and elastomeric type coatings and linings designated LC-24, 19, 34 and 100 have been added to the products manufactured by Lithcote Corp., 330 West 40th Place, Chicago, Ill.

•

Gortite Sleeves, accordion-type coverings for exposed segments of moving machinery which need protection against corrosive environments are made by A & A Manufacturing Company, 2017 West Clybourn St., Milwaukee, Wis. They can be made to order for special cross-sections, and are available on order with neoprene coated vulcanized seams.

•

Cooper Alloy 14S (Alloy Type 12 CrLC) is described in detail in a Cast Alloy Reference Sheet, a part of CA-Newscast, a periodical published by Cooper Alloy Foundry Co., Hillside, N. J. A table gives corrosion resistance to acids, alkalis, salts, wet and dry gases, organic materials and industrial environments.

•

An X-Ray Image Amplifier which makes images 800 to 1200 times brighter than those obtained with the conventional fluoroscope has been developed by Phillips Laboratories, Eindhoven, Holland and will be marketed soon in the United States. The increased intensity is achieved by converting the luminous fluorescent image into an electronic image.

(Continued on Page 19)

NEW PRODUCTS

(Continued from Page 18)

Ace Tempron, a new synthetic hard rubber compound developed by the American Hard Rubber Company, 93 Worth St., New York, N. Y. is based on nitrile synthetic. It is available as a construction material and in shapes. At room temperatures it resists many organic chemicals which attack natural rubber, manufacturers say, including hexane, hexene and other solvents such as benzene, carbon tetrachloride, ethyl acetate and benzaldehyde. It is resistant to oils but not recommended for sodium hypochlorite or strong oxidizing agents such as nitric acid. Its heat distortion temperature is 260-270 degrees F.

•

Glo-Quartz electric radiant immersion heaters manufactured by Glo-Quartz Electric Heater Co., Inc., 37934 Elm St., Willoughby, Ohio are recommended for heating all acid solutions except hydrofluoric acid. Heating elements are replaceable.

•

Rodine, pickling acid inhibitor is described in an illustrated 4-page folder available from American Chemical Paint Co., Ambler, Pa. Charts give recommended Rodine types and quantities for sulfuric acid and muriatic acid pickling solutions.

•

Nine years, five months and four days was the correct answer to the Metalweld "Guessing Contest" at the March NACE Conference in Chicago. The five persons whose guesses were closest to the actual service time of the rubber lined fitting were: C. L. Waterbury, C. M. St. P. & P. R. R., Chicago; C. G. Munger, Amercoat Corp., South Gate, Cal.; J. W. Godfrey, General Motors, Lockport, N. Y.; D. H. Carpenter, Sohio Petroleum Co., Oklahoma City and L. M. Plym, Bell Telephone Co., Chicago. Each received a barometer from Metalweld. The fitting was in service at Merck Company's Philadelphia plant.

BINDERY SERVICE

Readers of CORROSION who wish to have their copies of the magazine bound may apply to:

ART BOOKBINDERS
616 West 19th St.
Houston, Texas

The following options are suggested:

1. **Technical Section Only** **$3.50**
2. **Abstract Section Only** **3.50**
3. **Technical and Abstract Sections** **3.50**
4. **All Pages** **4.00**

These prices cover full cloth, hard cover, sewed volume with the name "Corrosion" and the Volume Number and Year stamped in gold on the back. All prices are net to the binder, transportation extra.

Transactions are between the individual and the binder and NACE will not be a party to nor does it offer any warranty of any nature in connection with any transaction. All correspondence should be with the binder directly and all billing will be direct to the purchaser from the binder.

***Behind the Scenes at* PLS ...**

Where Ideas Come to Life for More Dependable Protection

Here is another of the unseen services that give you more for your money in pipe cleaning, priming, coating and wrapping at PLS. In this modern machine shop, specialists convert the ideas born in the engineering laboratory into original equipment to serve all six Pipe Line Service plants. These machine shop facilities make possible constant improvements in equipment and service that are reflected in the high quality protection provided for PLS customers.

PIPE LINE SERVICE **PLS** **CORPORATION**

Pioneers in Steel Pipe Protection
General Office and Plant: Franklin Park, Illinois

Plants at Glenwillard, Penna.; Longview, Texas; Corpus Christi, Texas; Harvey, Louisiana; and Sparrows Point, Maryland

DEPENDABLE SERVICE SINCE 1931

NOMINATIONS FOR 1954 NACE AWARDS

Should Be Made Not Later Than July 1

The Procedure for the Selection of Persons to Receive the Willis Rodney Whitney and Frank Newman Speller Awards in 1954 as approved by the Board of Directors in Galveston, March 14, 1952, provides for nominations being made by a local section or by an individual member directly to the Chairman of a Region. All nominations should be accompanied by an appropriate statement of the basis of the proposal.

This Procedure requires that prior to July 1, 1953, the Regional Chairman shall forward to the Chairman of the Awards Committee all names proposed for awards, accompanied in each case by summaries of the reasons presented in support of each proposal, but with no indication of the number of duplicate nominations of any individual. The object of this latter provision is to insure that awards will be made on a basis of accompishments and other qualifications rather than by any semblance of a popular vote.

The Procedure also requires that the NACE membership be notified of their privileges with regard to nominating candidates for these awards either by direct letter not later than May 1, 1953, or through publication in the May, 1953 issue of CORROSION. A direct letter is not contemplated; hence, this notice as it appears in this issue of CORROSION Magazine will serve as the notification to the NACE membership that nominations for these two awards may be made to their respective Regional Chairman not later than July 1, 1953. Reference to the Regional Division map on page iv and the Directory of Regional and Sectional Officers on pages iv and v of this issue will enable any member to obtain the name and mailing address of the regional chairman to whom his nominations should be sent.

PERSONALS

Werner Jacobson, translator from and into Swedish, German, Dutch, Norwegian, Russian, Polish, Spanish, Portuguese, Italian, French, Chinese and other languages has moved to 2732 W. Lexington St., Chicago 12, Ill.

•

Frank Passal has been promoted to Assistant Director of Research, Plating Division, United Chromium, Inc.

•

H. E. Johnston has been named manager of the New York office of Dearborn Chemical Company. **E. R. Glover** has been named technical director of the company's railroad department.

•

Carl P. Zimmerer, secretary of Ebasco Services, Inc., New York died April 23. He joined the then Electric Bond and Share Company in 1915.

•

R. W. Stetson, formerly with Dow Chemical Company, where he gained experience on underground and underwater structures has been appointed vice-president of Stuart Steel Protection Corp., Kenilworth, N. Y.

•

Eugene R. Lopez, formerly assistant to the manager of protective coating sales, The Barrett Division, Allied Chemical & Dye Corp., has been named vice-president of Chemical Fire and Rust Proofing Corp., 11-33 31st Drive, Long Island City, N. Y. He will have charge of the company's sales of materials and service for pipe lines and marine structures.

Announcing

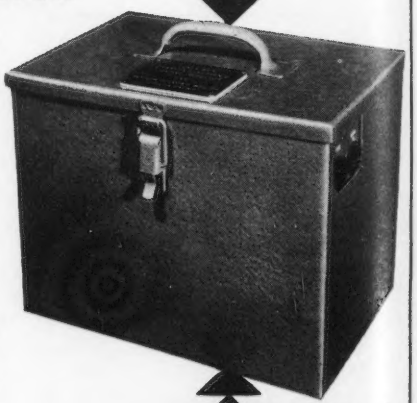
THE NEW AND IMPROVED
PEARSON ELECTRONIC COATING INSPECTOR

Used for locating voids in the coating of a completed pipe line — without uncovering the line — the new and improved Pearson Electronic Coating Inspector . . .

1. Has compact, light-weight receiver which weighs only 6 lbs.
2. Has greatly increased power output in signal generator which is arranged for self-contained batteries.
3. Has replaceable vibrator unit in signal generator for assuring continuous field operation.
4. Has carrying case which houses complete unit, and permits operation during bad weather.

First manufactured by "NEMCO" ten years ago, the new and improved Pearson Inspector is the outgrowth of considerable and varied field experience, plus much research and development work.

Write for new, illustrated Bulletin No. 941-A.



Outside view of metal carrying case

NELSON Electric MANUFACTURING CO.
217 N. Detroit St. TULSA, OKLAHOMA Telephone 2-5131

Corrosion Abstracts

CORROSION CONTROL — PROTECTS INDUSTRY — NATIONAL ASSOCIATION OF CORROSION ENGINEERS

Index to CORROSION ABSTRACTS

Vol. 9 June, 1953 No. 6

	Page
1. GENERAL	
1.2 Importance	101a
1.3 Reviews	102a
1.7 Organized Studies of Corrosion	102a
2. TESTING	
2.2 On Location Tests	104a
2.3 Laboratory Methods and Tests	106a
2.4 Instrumentation	107a
2.5 Specifications and Standardization	108a
3. CHARACTERISTIC CORROSION PHENOMENA	
3.2 Forms	108a
3.3 Biological Effects	109a
3.4 Chemical Effects	109a
3.5 Physical and Mechanical Effects	110a
3.6 Electrochemical Effects	110a
3.7 Metallurgical Effects	110a
3.8 Miscellaneous Principles	112a
4. CORROSIVE ENVIRONMENTS	
4.3 Chemicals, Inorganic	116a
4.4 Chemicals, Organic	116a
4.6 Water and Steam	118a
5. PREVENTIVE MEASURES	
5.2 Cathodic Protection	118a
5.3 Metallic Coatings	120a
5.4 Non-Metallic Coatings and Paints	122a
5.5 Oil and Grease Coatings	122a
5.6 Packaging	122a
5.8 Inhibitors and Passivators	124a
5.9 Surface Treatment	124a
6. MATERIALS OF CONSTRUCTION	
6.2 Ferrous Metals and Alloys	126a
6.3 Non-ferrous Metals and Alloys—Heavy	128a
6.4 Non-ferrous Metals and Alloys—Light	130a
6.6 Non-Metallic Materials	131a
6.7 Duplex Materials	131a
7. EQUIPMENT	
7.1 Engines, Bearings and Turbines	135a
7.2 Valves, Pipes and Meters	136a
7.3 Pumps, Compressors, Propellers, Impellers	137a
7.4 Heat Exchangers	137a
7.5 Containers	137a
7.6 Unit Process Equipment	137a
7.7 Electrical Telephone and Radio	138a
8. INDUSTRIES	
8.1 Group 1	140a
8.4 Group 4	140a
8.8 Group 8	141a

Write for Details
on
CORROSION ABSTRACTS
on
PUNCH CARDS

Learn how you can get abstracts on thousands of articles cross-indexed by the NACE Abstract Filing System.

NATIONAL ASSOCIATION
of
CORROSION ENGINEERS
1061 M & M Bldg. Houston, Texas

1. GENERAL

1.2 Importance

1.2.2, 5.2.1, 8.9.3

Economic Aspects of Cathodic Protection. RAY M. WAINWRIGHT. Presented at the Winter General Meeting, and at Portland Summer Meeting, August, 1951, of the American Institute of Electrical Engineers. *Corrosion*, 9, No. 2, 51-55 (1953) Feb.

The corrosion bill for metals in the United States amounts to more than 5½ billions of dollars each year. Cathodic protection measures could eliminate probably over a billion dollars worth of this corrosion. For pipelines, corrosion costs annually from 2 to 5 percent of the original investment. By means of proper coatings and cathodic protection the costs incidental to corrosion can be reduced to from 1 to 2 percent, annually, of the initial investment. Since the initial investments run into the billions of dollars, cathodic protection becomes a significant factor in the engineering economic picture.

A very important item is the possibility of reduction in steel content of pipelines based on modern methods of coating and cathodic protection. Besides the direct savings in operating and maintenance, other indirect savings include conservation of product, continuity of service and public relations improvements.

Annual cost accounting methods are advantageous for analysis of cathodic protection and coating economics. Costs may be reduced to expressions involving

PHOTOPRINTS and/or MICROFILM COPIES

of Technical Articles Abstracted in

CORROSION ABSTRACTS

May Be Obtained From

ENGINEERING SOCIETIES LIBRARY, 29 West 39th Street, New York 18, N. Y.

CARNEGIE LIBRARY OF PITTSBURGH, 4400 Forbes St., Pittsburgh 13, Pa.

NEW YORK PUBLIC LIBRARY, New York City.

U. S. DEPT. OF AGRICULTURE LIBRARY, Office of Librarian, Washington, D. C. (Special forms must be secured).

LIBRARY OF CONGRESS
Washington, D. C.

JOHN CRERAR LIBRARY
86 East Randolph St.,
Chicago 1, Ill.

Persons who wish to secure copies of articles when original sources are unavailable, may apply directly to any of the above for copies. Full reference information should accompany request. The National Association of Corrosion Engineers offers no warranty of any nature concerning these sources, and publishes the names for information only.

NACE will NOT accept orders for photoprint or microfilm copies of material not published by the association.

CODE OF AGENCIES SUPPLYING CORROSION ABSTRACTS

Neither NACE nor the sources listed below furnish reprint copies.

AER—Aeronautical Engineering Review, Institute of Aeronautical Sciences, Inc. 2 East 64th St., New York 21, N. Y.

ALL—The Abstract Bulletin, Aluminum Laboratories, Ltd. P. O. Box 84, Kingston, Ontario.

AWWA—Journal, American Water Works Association, Amer. Water Works Assoc., 521 Fifth Ave., New York 17, N. Y.

BL—Current Technical Literature, Bell Telephone Laboratories, Inc., Murray Hill, N. J.

BTR—Battelle Technical Review, Battelle Memorial Institute, 505 King Ave., Columbus 1, Ohio.

BNF—Bulletin; British Non-Ferrous Metals Research Association. 81-91 Euston St., London NW 1, England.

CALCO—Calco Chemical Division, American Cyanamid Corp. Bound Brook, New Jersey.

CE—Chemical Engineering, McGraw Hill Publishing Co. 330 W. 42nd St., New York 18, N. Y.

CEC—Consolidated Edison Co. of New York, Inc. 4 Irving Place, New York 3, New York.

EL—Electroplating. 83/85 Udney Park Road, Teddington, Middlesex, England.

EW—Electrical World, McGraw-Hill Publishing Co. 330 W. 42nd St., New York 18, N. Y.

GPC—General Petroleum Corp. of California. 2525 East 37th St., Los Angeles 11, Calif.

INCO—The International Nickel Co., Inc. 67 Wall Street, New York 5, New York.

IP—Institute of Petroleum. 26 Portland Place, London W#1, England.

JSPS—Japan Society for the Promotion of Science, Address: Mr. Hayata Shigeno, Secretary, Committee of Preventing Corrosion, c/o Government Chemical Industrial Research Institute, 1-Chrome Nakameguro, Meguro-ku, Tokyo, Japan.

MA—Metallurgical Abstracts, Institute of Metals, London, England. 4 Grosvenor Gardens, London SW 1, England.

MI—Metallurgia Italian. Associazone Italiana di Metallurgia. Via S. Paola, 10, Milano, Italia.

MR—Metals Review, American Society of Metals. 7301 Euclid Ave., Cleveland 3, Ohio.

NALCO—National Aluminate Corp. 6216 West 66th Place, Chicago 38, Illinois.

NBS—National Bureau of Standards. Supt. of Documents, U. S. Gov't Printing Office, Washington 25, D. C.

NSA—Nuclear Science Abstracts. United States Atomic Energy Commission, Technical Information Division, Oak Ridge, Tenn.

PDA—Prevention Deterioration Abstracts. National Research Council, 2101 Constitution Ave., Washington 25, D. C.

RA—Refrigeration Abstracts, American Society of Refrigeration Engineers. 40 West 40th St., New York 18, N. Y.

RM—Revue de Metallurgie, Paris, France. 5 Cite Pigalle, Paris (9e), France.

RPI—Review of Current Literature Relating to the Paint, Colour, Varnish and Allied Industries, Research Association of British Paint, Colour & Varnish Manufacturers, London. Waldegrave Rd., Teddington, Middlesex.

SE—Stahl Und Eisen, Verlag Stahleisen, M. B. H., Dusseldorf, August-Thyssen Str. 1, Postscheck Koln 4110, (22a) Dusseldorf, Germany.

TIME—Transactions of Institute of Marine Engineers. 85 The Minories, London EC 3, England.

UOP—Universal Oil Products. 310 South Michigan Ave., Chicago, Illinois.

ZDA—Zinc Development Association. Lincoln House, Turl Street, Oxford, England.

cathodic protection and coating requirements, and the optimum combination selected.

Partial protection is also very desirable in many cases involving poorly coated lines and can be justified by reductions in sinking fund deposit factors due to increased pipe life, in addition to usual savings in operations.

Electrical engineers should anticipate that cathodic protection will effect savings in other corrosion areas. Power plant equipment, cables, substations, docks, ships and other situations involving metals in contact with soils and solutions are fertile fields for the application of cathodic protection and modern techniques of corrosion control.

1.3 Reviews

1.3, 1.6, 5.1

Metal Finishing. Report of a Visit to the U.S.A. in 1950 of a Specialist Team Representing the British Metal Finishing Industry. 10 x 7½ in. Pp. xii + 75, with 31 illustrations. 1951. London. Anglo-American Council on Productivity, 21 Tothill Street, S. W. I. (3s. 6d, post free.).

This is a report of the metal-finishing team's visit to the United States, and describes the metal-finishing processes used in 21 plants. It also deals with such matters as specifications, research, management-labor relations, and safety.

It is essentially a readable document, and those concerned with metal finishing will find it of considerable interest and well worth the price. It is well written.

1.3, 5.1

Trends in Corrosion Control. H. H. Uhlig. Mass. Inst. of Tech. *Metal Progress*, **61**, No. 3, 82-88 (1952) Mar.

The roles of science and superstition and the use of steel and stainless steels in studying corrosion are discussed. The addition of copper and nickel in small quantities improves the resistance of unpainted steels. The applications and corrosion resistance of 18-8, Type 316, chromium-nickel-iron austenitic alloys, Types 347 and 321, and Hastelloy C are given. Use of tin, zinc, and nickel metal coatings to protect steels, clad coatings, paints and nonmetallic coatings, cathodic protection and organic coatings are discussed. Broader application of cathodic protection such as Duralumin clad with aluminum, more general application of resistant metals and alloys such as aluminium and stainless steel and increased use of protective metal coatings are the trend. When improved techniques for producing nonporous coatings are available the use of chromium and nickel coatings on steel will increase. Gas-phase reactions, for example stainless-chromium-iron alloy surfaces produced by reacting steel with gaseous chromous chloride at 1600°-1800°F, will be of commercial interest. More general use of inhibitors and de-aeration process, paints, ceramics and plastics and increased employment of corrosion engineers in industry are other trends. Illustrations.—INCO.

1.7 Organized Studies of Corrosion

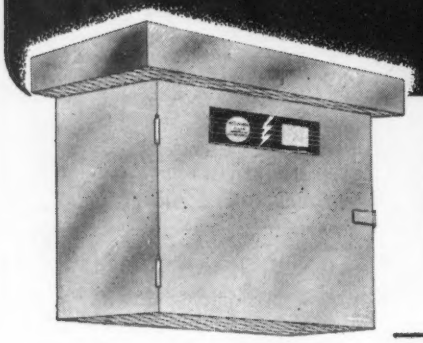
1.7.1, 1.6

Proceedings of the Second Meeting of the International Committee of Electrochemical Thermodynamics and Kinetics. 406 pages, 6¾ x 9⅜ inches, cloth. Libreria Editrice Politecnica Cesare Tamburini, via G. Pascoli, 55, Milano, Italya. Per copy* lire . . . 3800.

The proceedings of the second meeting of the International Committee of Electrochemical Thermodynamics and Kinetics contains several pages of informal photographs of the participants, a list of participants and authors, reports by the president and the secretary, forty scientific papers divided in six sections (electrochemical equilibria, electrochemical kinetics, corrosion, general and analytical chemistry, polarography, nomenclature and definitions) and an appendix containing a general report on the second meeting, a provisional set of rules for the committee and an index of authors and participants in the discussions.

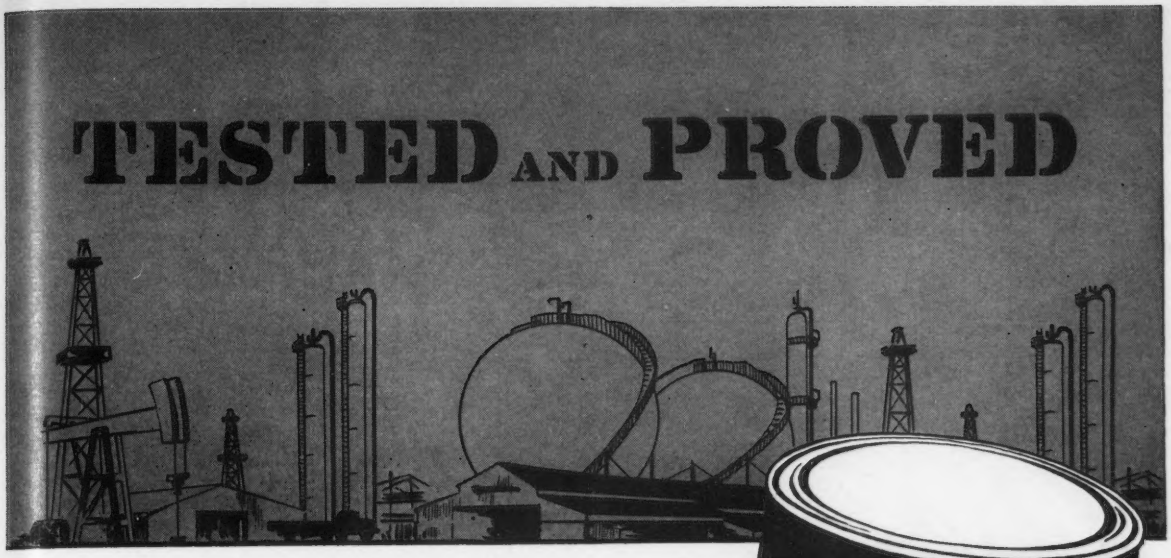
Eleven countries were represented at the meeting: Belgium, Canada, France, Germany, Great Britain, Italy, Norway, Spain, Switzerland, The Netherlands, United States of America. A total of about forty committee members were in attendance, and a number of delegates of Italian industrial firms and governmental organizations also attended the meetings.

Sections on equilibria and on corrosion which contains seven communications, although the other sections also contain articles with definite bearing on corrosion problems are included. The majority of the articles are in French, some in German and English. The volume gives an interesting cross-section of electrochemical research throughout the world.

YOUR MOST Dependable SOURCE
of cathodic protection against corrosion
The RICHARDSON-ALLEN

SELENIUM RECTIFIER
To overcome the problem of corrosion with cathodic protection, the R-A Selenium Rectifier offers you the most dependable source of the direct current required for the purpose.
It can be employed successfully in cases of buried or floating metallic structures, and to protect other equipment above the ground which is susceptible such as city water tanks, oil storage tanks, chemical plant devices, etc.
A Richardson-Allen engineer will be pleased to discuss your needs and show you the wide range of R-A Selenium Rectifier sizes.
Write for Descriptive Literature

Richardson-Allen Corporation
a manufacturing affiliate of
WESLEY BLOCK AND COMPANY, 39-15 MAIN ST., FLUSHING, N. Y.
IN CANADA: RICHARDSON-ALLEN OF CANADA, LTD., 370 VICTORIA STREET, TORONTO, ONTARIO
LEADING CONVERSION SPECIALISTS
102a

TESTED AND PROVED



"COPON", the new Coast-formulated epon resin coating for positive protection of metal surfaces . . .

"COPON" is now giving industry a truly remarkable new kind of protection against rust and corrosion from chemical fumes, acids, caustic alkali and salt water. And it is combining its revolutionary protective qualities with other such desirable features as (a) remarkable elasticity, (b) exceptional long life, (c) phenomenal tenacity to all types of metals.

May we give you more facts — or send you sample for your own testing?

Available in Primers, Finishing Enamel and Paints in all Colors.

CPL

COAST Paint & Lacquer Co. Inc.

P. O. BOX 1113 • HOUSTON, TEXAS

103a

The emphasis on fundamentals, typical of the committee's program, should be an inspiration in corrosion research and this volume is therefore highly recommended to individuals and laboratories engaged in such research.

Available to NACE members at a 20% discount obtainable from the publisher or from Dr. M. Pourbaix, University of Brussels, 50 Avenue Franklin D. Roosevelt, Brussels, Belgium.

1.7.2

Establishment of Tropical and Industrial Exposure Sites for Atmospheric Exposure and Corrosion Work. ASTM Bulletin, No. 176, 12-13 (1951) Sept.

In testing the corrosion of certain materials including non-ferrous metals, the following locations are being used: Tropical—Miraflores Canal Zone and Fort Sherman, on the west coast of the Canal Zone; Coastal sites—Kure Beach on the Atlantic Coast and Point Reyes on the Californian Pacific coast line; Industrial sites—New York, on the roof of a building at the corner of 15th Street and Eighth Avenue and also in East Chicago, Indiana; Semi-industrial—Columbus, Pennsylvania, and lastly the rural site in the Pennsylvania State College. Various firms in the United States have contributed towards the establishment and maintenance of these sites.—ALL.

2. TESTING

2.2 On Location Tests

2.2.2, 5.4.5

Outside Exposure Tests for Paints. G. M. AJAMANI. *Paintindia*, **1**, No. 9, 30 (1951).

Methods adapted by a number of authorities for exterior exposure tests for paints are reviewed briefly. The conditions of temperature and humidity in India are outlined as indicative of the widely varying factors involved in paint testing in India.—RPI.

2.2.3, 8.4.3

The Coupon Technique—A Valuable Tool in Corrosion Testing. H. L. BILHARTZ AND HOWARD E. GREENWELL. A paper presented at the Eighth Annual Conference, National Association of Corrosion Engineers, Galveston, Texas, March 10-14, 1952. *Corrosion*, **9**, No. 2, 66-73 (1953) Feb.

The "coupon technique" frequently is mentioned in the literature as a method of assessing corrosion. Little discussion, however, has been devoted to important details of procedure. As a result, those inexperienced in the art often draw misleading conclusions from reported data. It is the purpose of this paper to present a detailed description of one company's method of using coupons. A clearer understanding of details will make this important tool more valuable.

The "coupon technique" is the only single method of study which measures the effect of both physical and chemical variables of the corrosion environment. Small metal plates, commonly called coupons, are weighed and otherwise prepared for exposure, exposed to the well fluids for a number of days examined, cleaned of corrosion products and reweighed. Both qualitative and quantitative data are obtained. Careful examination and interpretation of the appearance of corrosion products adhering to the exposed coupons permits determination of the type attack which may be anticipated. The difference in weight before and after exposure places a numerical value on the corrosiveness.

This paper describes the coupon study procedure of one oil and gas producing company. Selection of coupon material, preparation of specimens, shipment and handling of coupons and methods of exposing under various conditions are discussed in detail. In addition, techniques of evaluating and processing exposed coupons are considered. The construction of special equipment for processing and storage of coupons is described.

The coupon technique has been used to study corrosion under many conditions. A list of environments which have been investigated through the use of this method include gas lift and gas injection systems, water injection wells, gasoline plants, condensate wells, oil wells of all types, tanks, cooling systems, etc. In general, the results of studies of gaseous systems can be interpreted most literally. Studies of liquid systems have been very valuable, but, occasionally, variables not related to the corrosion process have influenced results. A brief resume of these and other pertinent factors concerned with the use and limitations of the coupon technique is given.

2.2.5, 5.4.5

Field Tests for Paints. M. E. PARKER. *Oil Gas J.*, **50**, No. 41, 161 (1952) Feb. 18.

Paint manufacturers and other organizations have done, and are still doing, a great deal of work in the testing and evaluating of painting materials and methods for a variety of exposure conditions. Tests panels with all of the differ-

Standard Magnesium's new backfill packaging technique insures anode remaining centered in the chemicals regardless of shipping or handling.

For anodes with longer life and greater efficiency insist on Standard.

Inquiries Invited

Represented By

Moorlane Company
Tulsa, Okla.
Kansas City, Mo.
Amarillo, Texas
Denver, Colo.
Wichita, Kansas
Oklahoma City, Okla.

Midwestern Engine & Equipment
Tulsa, Okla.
Pittsburgh, Pa.
Atlanta, Ga.
Chicago, Ill.
Oklahoma City, Okla.

H. E. Davis
Los Angeles, Calif.

Robert F. Riley
Miami, Florida

Midwestern, Inc.
Houston, Texas

Standard Magnesium Corporation
TULSA, OKLAHOMA

Pioneers of: Spectographically Analyzed Anodes
Cylindrical Anodes

104a

Where INSUL-MASTIC stands guard!

Moist, salty atmosphere makes the Gulf Coast of Texas the *Playground of Corrosion.* Here Refineries and Chemical Plants rely upon Insul-Mastic Coatings for protection against rust. From Brownsville to Lake Charles you will find tanks, towers, pipes, vessels and other equipment heavily sprayed with this *Superior* coating. Maintenance operations everywhere have been greatly reduced because INSUL-MASTIC's protection will last for many, many years.

Stopping moisture alone does not prevent corrosion here. Acid, alkali and other industrial vapors work hard to break down coatings and get at the metal beneath. That's why the very durable INSUL-MASTIC coatings are so extensively specified along the Gulf Coast. They are extremely resistant to chemicals as well as to moisture.

INSUL-MASTIC's record in *corrosion's playground* cannot be approached. There are many years and hundreds of jobs to prove its lasting protection. Specify INSUL-MASTIC to prevent corrosion.

Insul-Mastic's record also includes vaporsealing thermal insulation. There's no better way to keep your insulation dry.

Think First of the Coatings that Last!

Insul-Mastic

CORPORATION OF AMERICA
Oliver Building • Pittsburgh 22, Pa.
Representatives in Principal Cities

105a

ent paints under consideration—including various combinations of primer and finish coats—should be exposed on properly designed racks and inspected on planned schedules. Panel size, surface preparation, rack design, rack location, and orientation all require consideration.—INCO.

2.2.2, 5.4.5

Exposure Panels. H. C. BRYSON. *Paint Manuf.*, **21,** No. 11, 420 (1951).

A new design of panel for outdoor weathering tests on paint is described. The panel is a metal strip 1 yd. long and ½-yd. wide, in the form of a central straight portion 2′ long having at either extremity pieces set at angles of 45° and 90° respectively. The panel is painted on both sides, and in effect offers six painted surfaces for examination, all being exposed at different angles to the horizontal in the exposure racks.—RPI.

2.2.2, 6.3.14, 6.3.19, 4.2.1

Weathering Tests of Tin-Zinc Alloy Coatings on Steel. S. C. BRITTON and R. M. ANGLES. (Tin Research Inst.) *Metallurgia,* **44,** No. 264, 185-191 (1951) Oct.

Results of weathering tests on electrodeposited tin-zinc alloy coatings in urban, suburban and marine atmospheres. In urban and suburban atmospheres, the protection given by coatings of equal thickness diminished in the order—zinc, 50 tin-50 zinc alloy, 80 tin-20 zinc alloy, cadmium. By the sea, an alloy with 50 tin was better than zinc and cadmium, but an 80 tin alloy was inferior to zinc and no better than cadmium. In tests involving more continuously humid conditions, tin-zinc alloy was superior to zinc. The steel sheets on which the coatings were deposited contained: 0.15 carbon, 0.35 manganese, 0.010 silicon, 0.065 phosphorus, 0.083 sulfur, 0.13 copper, 0.038 chromium and 0.16 nickel. Tables and pictures are included.—INCO.

2.3 Laboratory Methods and Tests

2.3.1, 5.9.4, 6.2.3

Tentative Analytical Tests for Phosphate Coatings on Steel. R. ST. J. PRESTON, R. H. SETTLE AND J. B. L. WORTHINGTON. *J. Iron Steel Inst.,* **170,** No. 1, 19-20 (1952) Jan.

Details of laboratory tests to determine the nature and uniformity of phosphate coatings are given. The tests consist of measurement of moisture content, absorption, coating weight, hygroscopicity, and the phosphate and chromate contents of the coatings.—BNF.

2.3.2, 5.3.2

Comparative Testing of Metal Coatings. GILBERT C. CLOSE. *Products Finishing,* **15,** No. 11, 20, 22 (1951).

A brief description of a testing device for exposing metal-coated specimens to different solutions under controlled conditions.—MA.

2.3.4, 3.4.7, 6.2.1

Semi-Accelerated Corrosion Tests of Medium and High Tensile Steel in Contact with Phenolic Foam. H. J. STARK, J. KAMINETSKY, and R. R. WINANS. *J. Am. Soc. Naval Engrs.,* **64,** No. 1, 49-57, (1952) Feb.

Objective of work was to determine whether the materials Phenolic foam B, Phenolic foam C, modified Phenolic foam C, and balsa wood contributed to or inhibited the corrosion of steel and the relationship if any between the pH measurements on water extracts of crushed samples and the observed corrosive effect. Discusses the method of test, results and conclusions. Both phenolic foams of the type described and balsa wood when in direct contact with steel and subjected to alternate synthetic salt water immersion and hot and dry conditions, produce a slightly accelerated corrosion in high tensile and mild steel. pH values do not appear to vary with the density of Phenolic foam tested. Tables and photographs are included.—INCO.

2.3.2, 5.9.2, 5.9.3

Evaluating Metal Cleaning Efficiency. S. SPRING. *Metal Finishing,* **50,** No. 2, 65-68 (1952) Feb.

The water spray pattern offers a useful procedure for the evaluation of partially soiled surfaces especially as a laboratory evaluative method. A viewing box to facilitate sketching of the soiled area pattern has been developed by Dr. Panepinto and Mr. H. R. Miller of the Pennsylvania Salt Manufacturing Company. The box is made of clear plastic and on each side are ruled 100 squares equal in area to the size of the metal panels used. Between two sides is a slot into which the metal panel fits so as to be in register with the ruled squares. The spray pattern is then traced with a wax pencil. The sum of the clear areas is taken as per cent cleaning. Water break tests offer greatest application with surfaces from which the bulk of the soil has been removed and in cases in which the soil is mainly oily in character. The following precautions should be taken in applying either the water spray or water break test: 1) Uniform metal surfaces should be used for laboratory tests; 2) Care should be taken to rinse off the last traces of surface-active agent; 3) Loosely adherent oil picked up from the surface of the rinse water should not be permitted to dry on to the metal.—ALL.

2.3.2, 6.4.4, 5.4.5

Finishing Magnesium for Assembly Protection. *Products Finishing,* **16,** No. 6, 78+ (1952) Mar.

In testing anodic corrosion of magnesium alloys at the Dow Chemical Company, FSl alloy was butt-joint riveted to 24ST aluminum. The assemblies were exposed in 20 percent salt spray at 95° F, in a positiion 10° from the vertical with the seam facing upward. A table gives the results. The chromates are only fair in reducing the corrosion rate of other bi-metallic couples—about 55 percent on untreated FSl alloy coupled with mild steel and immersed in 3 percent chloride solution. The moisture imperviousness of a paint film is more important than the inhibitive properties of chromate pigmentation for this type of protection. Primers with combined high moisture resistance and chromate pigmentation offer the best overall protection based on tests to date.—ALL.

2.3.4, 5.4.5, 4.3.7

Accelerated Tests on the Protective Power of Chromate Pigments in Presence of Sulphur Dioxide. C. BIGHI AND G. MANTOVANI. *Pitture e Vernici,* **7,** No. 4, 39-41, 43-44 (1951).

An apparatus is described for exposing painted panels to air containing known amounts of sulfur dioxide. Tests were carried out on iron panels coated with paints based on normal or basic lead chrome, zinc chrome, red lead oxide and mixtures of red lead oxide with the various chromes. All pigments were used in an alkyd medium with the exception of the straight red lead oxide, which was dispersed in linseed oil. After 120 days of test, corrosion had not proceeded far on any panels, but the red lead oxide lead chrome mixtures, on which a layer of lead sulfate had formed, were showing signs of rust. The straight zinc chrome paint had changed in color from yellow to a uniform green, but this change was not so marked with the lead chrome paints.—RPI.

2.3.4, 6.5

The Identification of Metals and Alloys by Chemical Spot Testing. C. T. WILSHAW. *Metallurgia,* **45,** No. 268, 102-106 (1952) Feb.

Methods described are for identification of materials rather than detection of a particular element. Covers ferrous materials and those non-ferrous alloys not readily separated from them by density of color: cupronickel, Monel, Hastelloys, chromium, stellite, steels, steels and high alloy steels.—BNF.

2.3.5, 3.6.8, 3.8.2

Methods of Measuring Polarization Potentials by Means of Model Experiments. (In German.) R. PIONTELLI, G. BIANCHI, AND R. ALETTI. *Z. Elektrochem.,* **56,** 86-93 (1952) Feb.

Study of above shows the important effect of environmental conditions on results. These point to certain conclusions, which are enumerated and discussed. Results for typical metallic ions are shown graphically and diagrammatically. 10 references.—BTR.

2.3.9, 3.5.3, 3.2.3, 5.9.4

Research on Friction and Wear. F. T. BARWELL. *Engineering,* **172,** 649-651, 697-699 (1951) Nov. 23-30.

Some of the work being done by the Mechanical Engineering Research Organization (D.S.I.R.), including study of surfaces by the "Talysurf" profilometer and by electron microscopy; investigation of composition and frictional effect of oxide films on aluminum, etc.; phosphating; molybdenum sulfide as lubricant; wear and scuffing; fretting corrosion; hydrodynamic lubrication; life of ball and roller bearings.—BNF.

2.3.9, 6.4.2, 3.7.4, 3.5.8

X-Ray Study of Ageing of the Aluminium-7% Magnesium Alloy. (MME) ADRIENNE R. WEILL. *Compt. rend.,* 234, No. 5, 523-526 (1952).

Whereas the ageing at 160° or 250° C of the aluminum-magnesium alloys of the AG7 type (7% magnesium) is accompanied by the formation of precipitates rich in magnesium, after 6 months at 55° C an X-ray examination reveals only great stress in the lattice, accompanied by a small increase in parameter which was not observable at higher temperatures before the appearance of the precipitates. It is proposed to develop the considerations of these observations later from the point of view of the stress-corrosion behavior of this alloy and the changes in the solid solution at about

normal temperature. Pierre Chevenard remarks that the decomposition of the quenched solid solution which by precipitation must end in reducing the dimensions of the crystalline structure, begins by an expansion of this lattice in the preliminary stage.—MA.

2.4 Instrumentation

2.4.2, 2.3.4

Alternate Immersion Corrosion Test Equipment. CHUK-CHING MA. *Ind. and Eng. Chem.*, **44**, 583-585 (1952) Mar.

The investigation was undertaken to simplify the design and construction of an alternate immersion corrosion test equipment. The characteristic features of the new design are the hanging of the specimen in horizontal position to ensure equal duration of immersion of all parts of the specimen in a corrosive medium, and the continuous up and down movement of the specimen to effect even distribution of corrosion conditions over the entire sample. Glass sewing thread was found most satisfactory for supporting specimens, for it resists the attack of acid, alkali and salt solutions. Because of its simplicity of construction, the new equipment costs substantially less than older types. Several series of corrosion tests on titanium, aluminum and stainless steels indicate that the reproducibility of experimental results, expressed as percentage deviation from average values, is in the range of 1 to 7 percent.—ALL.

2.4.2, 4.5.3, 2.2.6

Electrolytic Probe for Underground Corrosion Studies. W. BECK. American Electro Metal Corp. *J. Metals*, **3**, No. 9, 706-711 (1951) Sept.

The electrolytic probe technique is applied to determine the density of corrosive currents on buried steel and lead structures. The probe consists of a hollow half cylinder, placed on the outside surface of a line, connected to the installation through a current meter of low internal resistance. Examples of its use are cited. Graphs and 11 references are given.—INCO.

2.4.3

Advantages of X-Ray Inspection. J. RIGBY. *Canadian Metals*, **15**, 36-37 (1952) April 1.

Limitations of X-rays, flaw location, scatter effects, penetration, fluoroscopy, and limitation of radiography, Gamma radiography is included, noting that radioisotopes are adding versatility (by offsetting cost), portability, and range limitations.—MR.

2.4.3, 1.1

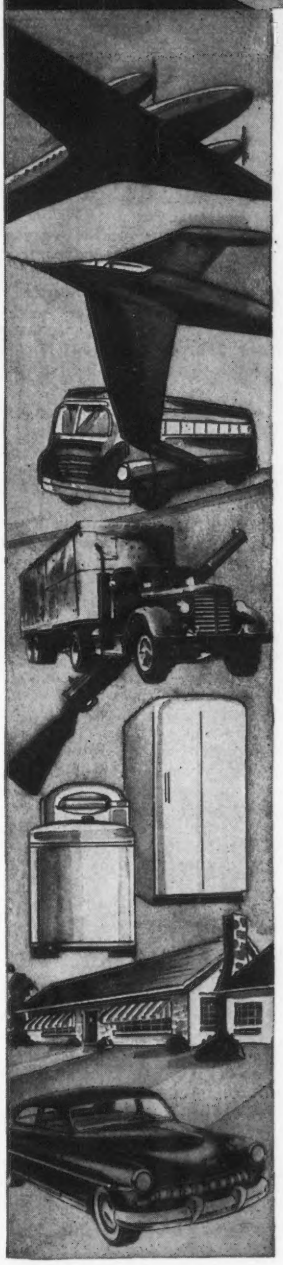
Management's Responsibility for Insistence on Non-Destructive Testing in the Development of New Engineering Products and Processes. LESLIE W. BALL. A.S.T.M. Symposium on the Role of Non-Destructive Testing in the Economics of Production, 148-151; discussion, 152 (1951).

Ball considers that "an engineering manager who neglects to exploit nondestructive testing in the development of a new engineering product or process, fails in what may well be one of his most vital management responsibilities." This contention is backed by 13 years of experience, and a few factual case histories.—MA.

CHEMICALS ACP PROCESSES

phosphate coating chemicals

TO MAKE YOUR PRODUCT DURABLE



PAINT BONDING

"GRANODINE"® forms a zinc-iron phosphate-coating bond on sheet metal products—automobile bodies and fenders, refrigerator cabinets, etc.—for a durable, lustrous paint finish.

"LITHOFORM"® makes paint stick to galvanized iron and other zinc and cadmium surfaces.

"ALODINE",® the new ACP protective coating chemical for aluminum, anchors the paint finish and protects the metal.

RUST PROOFING

"PERMADINE",® a zinc phosphate coating chemical, forms on steel an oil-adsorptive coating which bonds rust-inhibiting oils such as "Granoleum."

"THERMOIL-GRANODINE"® a manganese-iron phosphate coating chemical, forms on steel a dense crystalline coating which, when oiled or painted, inhibits corrosion.

PROTECTION FOR FRICTION SURFACES

The oiled "THERMOIL-GRANODINE" coating on pistons, piston rings, cranks, camshafts and other rubbing parts, allows safe break-in operation, eliminates metal-to-metal contact, maintains lubrication and reduces the danger of scuffing, scoring, galling, welding and tearing.

IMPROVED DRAWING AND COLD FORMING

"GRANODRAW"® forms on pickled surfaces a tightly-bound adherent, zinc-iron phosphate coating which facilitates the cold mechanical deformation of steel, improves drawing, and lengthens die life.

Send for descriptive folders and Government specifications chart on the above chemicals. Write or call for more information on these products, and advice on your own metal-working problem.

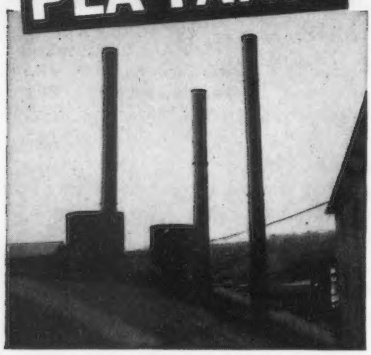
AMERICAN CHEMICAL PAINT COMPANY

General Offices: Ambler, Penna.

Niles, Calif. Detroit, Mich. Windsor, Ont.

107a

FUME STACKS of PLA-TANK®



Day by day, more and more PLA-TANK Stacks go to work helping to solve corrosion problems.

PLA-TANK STACKS
are manufactured from long-life resin-bonded glass fiber.

PLA-TANK STACKS
are resistant to a wide variety of fumes and temperatures. Not affected by extremes in weather.

PLA-TANK STACKS
are light in weight, relieve danger of collapsing and sagging roofs; need less support. Save on handling, freight and shipping charges.

PLA-TANK STACKS
are easy to install, require less rigging.

PLA-TANK STACKS
are competitively priced with other corrosion-resistant materials.

PLA-TANK STACKS
are available now in diameters to 54".

PLA-TANK STACKS
are the answer to your needs for many fume exhaust jobs now on your drawing boards or for replacements in existing systems.

Write for free data file sheet

P-11

THE Chemical CORPORATION

65 Waltham Ave., Springfield 9, Mass.

2.4.3, 2.3.7, 2.4.2, 1.3

Measurement of the Thickness of Layers or Thin Films. R. BERTHOLD. *Metaux: Corrosion Industries*, **26**, No. 313, 369-374 (1951) Sept. (In French.)

A review of non-destructive methods of measuring the thickness of coating and thin films, apart from those using ultrasound or X-rays. Two instruments are described and illustrated which are suitable for testing the thickness of zinc coatings on steel.—ZDA.

2.4.3, 2.3.9

Some Sources of Error in Ultrasonic Testing of Welded Metal Articles. PAUL BASTIEN. *Metaux; Corrosion Industries*, **26**, No. 307, 135-141 (1951).

Bastien examines various sources of error in ultrasonic testing by reflection and transmission arising from: (a) physical and geometric conditions of emission, (b) relationships between wavelength and physico-chemical characteristics of the medium, and (c) physical conditions of the material tested and nature of defects. The advantages of varying the positions of emitter and receiver and of using a range of wavelengths are stressed.—MA.

2.4.3, 2.3.9

Physical Aspects of the Testing of Metals by Means of Ultrasonics. (In French.) H. J. SEEMANN. *Metaux: Corrosion-Industries*, **27**, 14-23 (1952) Jan.

Discusses the problem of the absorption and dispersion of ultrasonic waves in solid bodies of polycrystalline structure, on the basis of the literature. Data are tabulated and charted. 17 references. —BTR.

2.4.3, 2.3.9, 2.4.2

Field Inspection of Boiler Tubes With Ultrasonic Reflectoscope. J. A. TASH. *Trans. Am. Soc. Mech. Engrs.*, **74**, 201-206 (1952) Feb.

Details are given of the Ultrasonic Reflectoscope and its use in detecting defective small diameter tubing. By means of the Ultrasonic Shear-Wave Method and the reflectoscope, 90 sections of defective tubing, representing over 1500 feet, were detected and replaced in the convection-superheater outlet section of two boilers.—MR.

2.4.3, 8.9.4

Testing of Railroad Rails by the Ultrasonic Resonance Method. PETER K. BLOCH. *Non-Destructive Testing*, **10**, 16-18 (1951-1952) Winter.

The ultrasonic resonance method lends itself to the design of relatively simple, portable, battery-operated equipment. In addition to testing rail ends at joint, this equipment is practical for testing rail in other critical locations such as frogs, switches, grade crossings, water pans, tunnels, etc.—MR.

2.5 Specifications and Standardization

2.5, 1.2.4, 5.4.5

Protective Coating Requirements by the Bureau of Yards and Docks. *Paint and Varnish Production*, **42**, 22-23 (1952) May.

Applies to construction and maintenance of shore installations including Navy bases, aircraft stations, and Marine bases. Includes color schedule and preparation of surfaces and painting of steel pilings.—BTR.

3. CHARACTERISTIC CORROSION PHENOMENA

3.2 Forms

3.2.2, 3.5.8, 7.6.4

The Prevention of Embrittlement Cracking. A. A. BERK. *Trans. Am. Soc. Mech. Eng.*, **73**, 859-864 (1951) Oct.

Nitrate, quebracho tannin, and zero-caustic treatment were applied successfully in stationary plants to prevent cracking in embrittlement-detector specimens. On one large railroad, prevention of cracking in detector specimens has paralleled a spectacular decrease in boiler-seam cracking in locomotive engines. The principal conclusion from a survey of cracking in stationary boilers in the last ten years is that embrittlement is not a frequent occurrence. 14 references. —MR.

3.2.2, 3.5.9, 6.2.3, 3.5.7

High-Temperature Hydrogen Attack on Steel. M. E. PARKER. *Oil Gas J.*, 50, No. 36, 124 (1952) Jan. 14.

Conditions for hydrogen attack on steel are found in ordinary low-carbon steels. The iron carbides present react with the hydrogen forming methane. The methane molecule is too large to diffuse, and is thus trapped, with the building up of extremely high localized pressures. If the affected vessel does not fail, it occurs generally along the grain boundaries, the effect of this hydrogen attack can be detected by the pronounced changes it brings about in the physical properties of the steel. Unless it is possible to modify the process so as to reduce the hydrogen concentration, or to lower either the operating temperature or pressure, there is no effective method of combating this attack except by the substitution of more resistant materials for the low-carbon steel.—INCO.

3.2.2, 3.7.2, 3.7.3, 6.2.5

Preventing Intergranular Corrosion Due to Welding Stainless. S. C. ORR, The Pfaudler Co. *Chem. Eng.*, **59**, No. 3, 286+ (1952) Mar.

Three commonly used methods for prevention of intergranular corrosion in stainless steel are discussed. They are holding carbon to a minimum content, locking up the carbon with a stabilizing agent, and heat treatment. Proper heat treatment of the unstabilized 300 series stainless steels can restore the chemical resistivity of fabricated equipment for chemical service to a degree comparable to that obtained with the critical stabilized materials. Roles of alloying elements such as, carbon, chromium, nickel, molybdenum, niobium and titanium are investigated. The degree of carbide precipitation encountered in stainless steel is influenced by the temperature of exposure within the sensitization range, time of exposure, carbon content and alloy composition. The most common source of carbide precipitation in the fabrication of 18-8 equipment is the heat of welding. Other sources are forging, hot forming and flame or powder cutting. Extra low carbon grades, stabilized stainless steels, and advantages of heat treatment are considered.—INCO.

3.2.2, 3.7.3, 6.2.5

Weld Decay in Stainless Steels. M. E. PARKER. *Oil Gas J.*, **50**, No. 50, 179 (1952) April 21.

Intergranular attack occurs when aus-

tenitic stainless steels are welded in the range of 700°-1500° F where loss of good properties increases with the carbon content increase and iron and chromium carbides with a lowering of chromium content, are formed. Proper annealing after welding overcomes the damage done. Increasing the chromium content in 18-8, 25-12 and 25-20 steel does not help. 18-8 is subject to intergranular corrosion even when the carbon content is lowered. Addition of titanium inhibits intergranular corrosion completely by stabilizing the carbides in steel but does not transfer well from welding rod to weld. Niobium, used in 18-8, performs the same function and transfers well. Niobium-bearing 18-8 rod can be used for welding both titanium-stabilized and niobium-stabilized steels.—INCO.

3.2.3, 3.2.2, 7.6.4

Concentrating Films: Their Role in Boiler Scale and Corrosion Problems. H. M. RIVERS. Hall Labs. Inc. Paper before Eng.'s Soc. of Western Penn., 12th Ann. Water Conf. *Combustion*, **23**, No. 10, 57-63 (1952) Apr.

Causes of the formation of highly concentrated films on steaming surfaces are given. Investigative procedure is illustrated and discussed. Mechanism of steam generation and scale formation, characteristic effect of concentrating films, problems associated with the degree of film concentration, formation of complex silicates and concentrating film under normal heatflow conditions are considered. Caustic concentration as low as 5% may be aggressive to boiler steel. At this and higher caustic concentrations, the protective oxide coating over metal tends to dissolve. Metal so exposed reacts with water to form a new protective film of ferrous oxide but when the caustic concentration is high enough to prevent this, caustic corrosion and production of hydrogen, making the metal brittle, occur. Tables.—INCO.

3.3 Biological Effects

3.3.4

Corrosion by Microorganisms. (In German.) H. O. NICOLAUS. *Zeitschrift des Vereines Deutscher Ingenieure*, 94, 39 (1952) Jan. 11.

Describes briefly the chemistry of biologically caused corrosion and proposes some effective means of combating it.—BLR.

3.3.4, 2.3.5, 5.8.2

Electrochemical Studies of Anaerobic Corrosion in Presence of Sulphate-Reducing Bacteria. F. WORMWELL AND T. W. FARRER. *Chemistry & Industry*, No. 5, 108-109 (1952) Feb. 2.

Potential measurements of mild steel specimens in various culture media (pH 7.2) with and without inoculation of sulphate-reducing bacteria (Desulfovibrio desulfuricans). It is suggested that bacterial activity reduces both anodic and cathodic polarization. Chromates and proflavine inhibit bacterial activity, while 2.5% bentonite addition produces effects similar to those found in clay soils.—BNF.

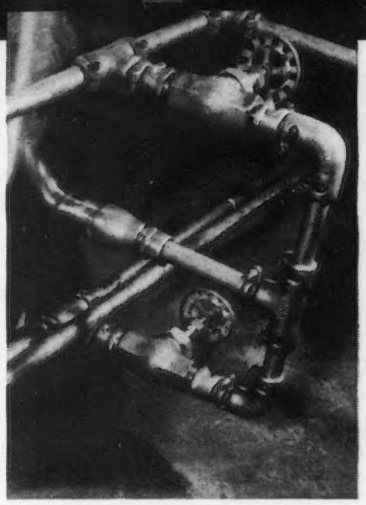
3.4 Chemical Effects

3.5.8, 1.6

Fatigue and Fracture of Metals, a Symposium. Edited by WILLIAM M.

In production **ahead of schedule** . . . thanks to

Quikupl®



Says **PRECISION FILM LABS**
NEW YORK, N. Y.

"A quick glance at the piping layout in the print told us that we had to install about 1000 feet of stainless piping and more than 700 stainless fittings. Thinking in terms of conventional assembly methods, this meant three months of work before we could start operations."

"Just about this time, Quikupl became available. In addition to putting us in business eight weeks ahead of schedule, it sliced 40-50% off our estimated installation costs. And what's more, we now have a stainless processing line that we can tear down in a jiffy for clean-out or rearrangement."

"Cost conscious plant men will find Quikupl worth investigating."

BULLETIN Q100

Get the full story of this amazing stainless steel fitting which permits quick assembly and disassembly of stainless pipes or tubing without threading, flaring or welding.

Write for Bulletin Q100 today.

THE **COOPER ALLOY**
FOUNDRY CO. • HILLSIDE, NEW JERSEY

NAME _____

POSITION _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

MURRAY, Massachusetts Institute of Technology. (1952) 313 pages. Published by John Wiley & Sons and, The Technology Press, Massachusetts Institute of Technology. $6.00.

The book presents the views of 18 specialists at a special conference on the fatigue and fracture of metals held in June 1950 at the Massachusetts Institute of Technology.

The volume includes the following discussions: General Survey of the Problems of Fatigue and Fracture, The Fatigue Problem in Airplane Structures, Brittle Fracture and Fatigue in Ships, Brittle Fracture and Fatigue in Machinery, Internal Stresses and Fatigue, Designing for Fatigue, and Fundamentals of Brittle Behavior in Metals.

Further contributions include: Experimental Study on Temper Brittleness of Slightly Alloyed Carbon Steel, The Statistical Aspect of Fatigue Failures and Its Consequences, A Review of Cumulative Damage in Fatigue, Significance of Transition Temperature in Fatigue, The Influence of Metallographic Structure on Fatigue, Fatigue at Elevated Temperatures and The Techniques of Physical Metallurgy for Studying Fatigue Damage.

3.5 Physical and Mechanical Effects

3.5.8, 7.6.4

The Creep and Stress-Rupture Testing of Steam-Boiler Materials. J. R. ROMER, AND H. D. NEWELL. *Trans. Am. Soc. Mech. Engrs.*, **74,** 157-174 (1952) Feb.

The significance of the time factor in testing in relationship to long-life, high-performance, steam-generating equipment is discussed as are the general effects of metal oxidation from steam and combustion atmospheres. Relative merits of long-time creep tests and stress-rupture tests are considered, and typical tests data are cited for each form of test. Gives suggestions for temperature limits for superheater-tube materials and a resumé of field experience on carbon and alloy steels. 32 references.—BLR.

3.6 Electrochemical Effects

3.6.4, 2.3.9

Study of the Distribution of Surface Potential by Means of Radioactive Deposits. T. WESTERMARK AND L. G. ERWALL. *Nature*, **169,** 703-704 (1952) Apr. 26.

Experiments on the contact potentials of polished metallic surfaces. A special camera of cylindrical form was constructed containing a radiothorium source. A uniform electric field can be maintained in the space between the source and a collecting disk. After exposure, the disk is removed and an autoradiograph prepared. The method has so far been applied only to a few alloys; but it is believed to be of rather general applicability, provided the contact-potential differences are not too small.—BTR.

3.6.4, 3.2.3, 3.5.7

Contact Potential Variations on Freshly Condensed Metal Films at Low Pressures. L. L. ANTES AND N. HACKERMAN, University of Texas. Based in part on a dissertation by L. L. Antes presented to University of Texas. *J, Applied Physics*, **22,** No. 12, 1395-1398 (1951) Dec.

Reason for contact differences of potential is discussed. The change of contact potential as a function of time for various freshly evaporated metal films in high vacuums is discussed and curves are presented. Results obtained indicate characteristically different behavior for the metals, aluminum, copper, gold, nickel, iron and chromium which were studied. Electrical resistance measurements made on similar metal films under similar conditions are correlated with contact potential measurements.—INCO.

3.7 Metallurgical Effects

3.7.2, 6.3.6

Constitution and Properties of Some Iron-Bearing Cupro-Nickel. TP 3203E. E. W. PALMER AND F. H. WILSON. Am. Brass Co. Paper before AIME, Ann. Mtg. New York, Feb. 18-21, 1952. *J. Metals* (Trans. AIME), **4,** No. 1, 55-64 (1952) Jan.

Solid solubility of iron in 2-10% cupro-nickel increases with temperature and nickel content. Property changes accompanying various heat treatments indicate typical precipitation hardening behavior. Iron content also affects softening temperature and sub-scale formation. These factors, as well as impingement corrosion resistance, influence the optimum iron content of commercial alloys. Photomicrographs, graphs, tables and 8 references are included.—INCO.

3.7.3

Modern Developments in Metallizing. S. TOUR, Sam Tour & Co., Inc. Paper before AWS, 32nd Ann. Mtg., Detroit, Oct. 15, 1951. *Welding J.*, **31,** No. 3, 199-207 (1952) Mar.

New improvements are the wire metallizing gun and the development of molybdenum wire for metallizing. Molybdenum wire forms a satisfactory bond on all common and stainless steel, Monel, nickel, chromium-nickel alloys. A special chromium-nickel alloy sprayed on steel surface and coated with a special sealer containing aluminum flakes gives temperature protection in ranges of 1600°-1800° F. Spraying a chromium-nickel alloy and pure aluminum and applying a sealer coat of a vehicle containing aluminum pigment gives protection above 1800° F. When put into operation the spray metal forms a chromium-nickel-aluminum and iron alloy. Cobalt-chromium-nickel and cobalt-nickel-chromium-iron-boron-silicon alloys, lead or tin babbits in wire form, nickel, Monel, lead, zinc, tin, aluminum and copper can be used as sprayed coatings. Austenitic stainless steels of high-carbon content, high-chromium or plain carbonsteels of various carbon content can be sprayed. Tables of wire gun capacities (hand) using acetylene gas plus oxygen and wire gun capacities (heavy duty) using acetylene plus oxygen and 3/16 in. diameter for Monel, nickel, 18-8, high carbon chrome stainless and carbon-steel are given. Properties of sprayed metal coatings are tabulated and discussed.—INCO.

3.7.3, 5.9.4, 5.4.7, 1.2.4

Blitz Cans Receive Corrosion Resisting Specifications Finish. E. A. BLOUNT. *Products Finishing (U.S.A.)*, **15,** No. 10, 38-52 (1951).

The five-gallon petrol can, more commonly known as the "Blitz Can," is fabricated and finished at the rate of 500-600 per hour at the Conco Engineering Works, Mendota, Illinois. Through metal pre-treatment including Bonderizing, careful handling, and a specification finish of electrostatic spray enamelling under controlled conditions result in a product which meets the rigid test requirements of the Armed Services.—EL.

3.7.3, 6.2.5

Effect of Heat Treatment and Related Factors on Straight-Chromium Stainless Steels. F. KENNETH BLOOM. A paper presented at a meeting of South Central Region, National Association of Corrosion Engineers, New Orleans, La., Oct. 1-3, 1952. *Corrosion*, **9,** No. 2, 56-65 (1953) Feb.

The hardenable straight chromium stainless steels find increasing application in the oil and petroleum industry where combined high strength and corrosion resistance are desired. To assist engineers in the proper selection of these alloys the effect of heat-treatment on their mechanical properties and corrosion resistance is reviewed. The general relationship between structural changes caused by heat-treatment and hardness, toughness and corrosion resistance is first discussed and specific data are then given for each grade. The undesirable effects of carburization are briefly discussed.

3.7.3, 6.2.5

Aircomatic Welding of Austenitic Stainless Steels. W. G. BENZ, JR., AND J. S. SOHN. *Welding J.*, **30,** 911-926 (1951) Oct.

Presents results of an investigation of the mechanical properties and resistance to corrosion of austenitic chromium-nickel grades of stainless-steel weld metal and welded joints deposited by the inert-gas-shielded metal-arc process. Data are tabulated and graphed. Illustrations and microphotos. 14 references.—BLR.

3.7.3, 6.3.11, 6.3.15

Titanium Aids Silver Brazing. ARNOLD S. ROSE. *Iron Age*, **169,** 96-97 (1952) Mar. 20.

Non-brazing qualities of titanium have proved helpful in silver soldering a Type 321 stainless-steel assembly in fused potassium chloride-sodium chloride bath. Titanium strips around the assembly act as dams and hold the silver solder in place. The salt bath operates at 1350° F. Rings must be replaced after 25 hr. exposure.—BTR.

3.7.4, 1.6, 1.4

Symposium on the Nature, Occurrence, and Effects of the Sigma Phase. Presented at the Fifty-Third Annual Meeting, American Society for Testing Materials, Atlantic City, N. J., 26-27 June 1950. (Special Technical Publication No. 110) 9 x 6 in. Pp. (v) +181, illustrated. 1951. Philadelphia (3), Pa.: The American Society for Testing Materials, 1916 Race Street. ($2.50.)

Contents: 1) "Identification and Mode of Formation and Re-Solution of Sigma Phase in Austenitic Chromium-Nickel Steels." E. J. DULIS AND G. V. SMITH. (Met. Abs., **18,** 654, 1950-1951.) 2) "Sigma Phase in Several Cast Austenitic Steels." V. T. MALCOLM AND S. LOW. (Met. Abs., **18,** 654, 1950-1951.) 3) "X-Ray Study of the Sigma Phase in Various Alloy Systems." POL DUWEZ AND SPENCER R. BAEN. (Met. Abs., **18,** 172, 1950-1951.) 4) "Sigma Phase in Chromium-Molybdenum Alloys with Iron or Nickel." JOHN W. PUTNAM, N. J. GRANT, AND D. S. BLOOM. 5) "The Tetragonality of the Sigma Phase in the Iron-Chromium System." L. MENEZES,

UNICHROME Trade Mark

News about
COATINGS for METALS
Metallic . . . . . Organic . . . . . Decorative . . . . . Protective

Practical Painting for Corrosion-Plagued Plants

Drum lining problem solved with extra thick coating

A concrete hardener of the fluosilicate-wetting agent type has long created shipping problems because of its quick reaction with steel. Unprotected, steel drums corroded and hazardous gas was formed. Ordinary linings didn't withstand this solution. The extra resistance was obtained with the thick, resilient vinyl plastisol coating provided by Unichrome Series 4000 Drum Linings.

Write for data on the complete variety of linings available from United Chromium.

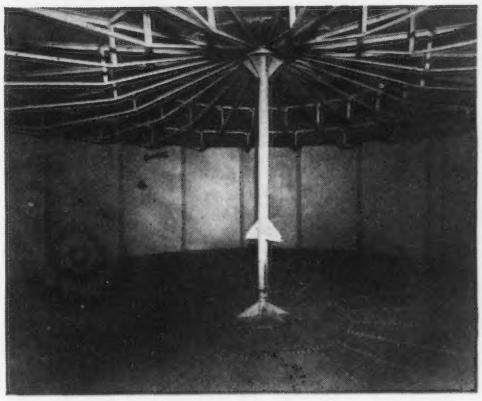
Plastisol coating outlasts metal 4 to 1 in corrosive use

Here's a case showing the extraordinary protection that can be given to metals in processing equipment.

Bleach reduction chambers of a noted chemical producer were coated with a Unichrome Plastisol Compound. This user reported that the coating gave 4 times longer service than even special alloy metals before requiring maintenance! The exceptional chemical resistance displayed by these vinyl coatings is fortified by the thickness they develop—up to 3/16". Tough and elastic, they bake to stable form at 350°F. The Technical Service Department of United Chromium can be consulted on the suitability of these compounds for any specific application.

UNITED CHROMIUM, INCORPORATED
100 East 42nd Street, New York 17, N. Y.
Detroit 20, Mich. • Waterbury 20, Conn.
Chicago 4, Ill. • Los Angeles 13, Calif.
In Canada:
United Chromium Limited, Toronto, Ont.

Ucilon Protective Coatings provide proved systems for controlling damage and excessive painting costs



Protected with Ucilon Coatings, this 1000 bbl bolted steel tank handles 93,000 bbls of brine monthly. The particular coating system applied has been used also in a Michigan chemical plant for interiors of brine tanks, and is still in excellent condition after 5 years service.

EXPERIENCE has proved time and again that stopping corrosion before it starts damage requires a *systematic* approach. This means preventive maintenance done on a regular and *timely* basis. It means adequate surface preparation when needed—to assure optimum results that cost you less in the long run. And finally, it means selection of a system of coatings engineered to meet the job requirements.

Systems of coatings such as Ucilon materials take guesswork out of heavy duty protective painting. Actually, they comprise a complete "package" for the required protection and durability. As required, they may include special primers for adhesion, or to prevent undercutting in the event of a break in film continuity. Sometimes an intercoat material may be included for improving adhesion or abrasion and corrosion resistance. And, of course, they include *specialized* topcoats. Ucilon Coating Systems even specify details on surface preparation and the number of coats needed to control various corrosive conditions. *Trade Mark

SYSTEMS FOR "101" CORROSIVES

Sixteen systems of Ucilon Coatings give engineers wide latitude for specifying the right protection against acids, alkalies, salt solutions, alcohols, moisture, oils and other products.

Individual coating materials include vinyl, chlorinated rubber, phenolic and fish oil formulations.

CASES OF PRACTICAL PROTECTION

In the plant of a Midwest chemical producer, areas subjected to strong hydrochloric acid fumes were protected by Ucilon Coating System "A." Applied 5 years ago, the coatings are still in remarkable condition—with virtually no patchwork or maintenance during this service.

Plating departments with their highly corrosive solutions and humidity make an ideal proving ground for coating systems. Ucilon Coating Systems have given 2, 3 and more years of service. In fact, because of durability, they were selected for the largest wire plating machine in the world at the plant of a famous concern.

Ucilon System "H" was used in the interior of a tank car transporting an ammoniated saturated nitrate solution. It showed no failure even after a year of contact with this tough-on-coatings chemical.

★ ★ ★

With modern protection such as afforded by Ucilon Coatings, corrosion control has become a practical procedure under conditions once regarded as hopeless. Systematic use of these coatings offers longer lasting equipment and savings on painting costs.

Be sure to look up the concise facts on Ucilon in your latest "C.E.C." Or write for bulletin No. MC-7.

111a

J. K. Roros, and T. A. Read. 6) "The Formation of Sigma Phase in 17 Percent Chromium Steel." J. J. Heger. (Met. Abs., **18**, 654, 1950-1951.) 7) "Sigma Phase and Other Effects of Prolonged Heating at Elevated Temperatures on 25 percent Chromium-20 percent Nickel Steel." G. N. Emmanuel. (Met. Abs., **18**, 654, 1950-1951.) 8) "The Occurrence of the Sigma Phase and Its Effect on Certain Properties of Cast Fe-Ni-Cr Alloys." J. H. Jackson. 9) "The Formation of Sigma and Its Influence on the Behavior of Stabilized 18 percent Chromium-8 percent. Nickel Steels in Concentrated Nitric Acid." Raymond S. Stewart and Stephen F. Urban. 10) "Some Notes on the Structure and Impact Resistance of Niobium-Bearing 18:8 Steels After Exposure to Elevated Temperatures." W. O. Binder. 11) "Observation of the Effect of Sigma on the Mechanical Properties of Niobium-Stabilized Weldments in Austenitic Stainless Steels." F. W. Schmitz and M. A. Scheil.—MA.

3.7.4, 2.3.2, 6.2.3

New Reagents for the Purpose of Revealing the Micrographic Structures of Steel by the Formation of Colored Films. (In French.) Louis Beaujard. *Compt. rendus*, **233**, 653-655 (1951) Sept. 17.

An alkaline reagent of a given composition was used for above purpose. The various colorations reveal the physical and chemical heretogeneity of the metal.—BLR.

3.7.4, 3.8.1

Phase Boundaries Particularly as They Effect Corrosion. R. Auerbach. *Werkstoffe u. Korrosion* (Germany), **2**, No. 10, 365-367 (1951) Oct.

Two phases have a common cleavage-plane, while three phases have only one common boundary line. Corresponding to an adsorption in the first case is an adlineation in the second case. Both processes diminish the free energy and hence the activity of the boundary, thus inhibiting the possibilities of corrosion. Local elements, incandescent cathodes and catalysts consisting of several components are typical systems acting at microscopic boundary-lines. Cavitation is the inverse phenomenon. Macroscopic boundary-lines in partially filled containers, formed by wall, liquid and gaseous phase, are particularly active, since they form a four-phase system, which results from the heterogeneity of the container wall. Gravity potentials and electrokinetic potentials have their maximum value at the boundary-lines also.—ALL.

3.7.4, 6.5

Structure and Corrosion. (In Russian.) G. V. Akimov. Izvest. Akad. Nauk S.S.S.R., Section of Chemical Sciences (Bull, Acad. Sci. U.R.S.S.), 469-480 (1951) Sept.-Oct.

The different types of corrosive attack are discussed and illustrated with microphotographs and tabulated corrosion rates of the following metals and alloys in various salt, acid, and hydrogen peroxide solutions: aluminum, aluminum-1% iron, copper, copper-0.5% gold, cadmium, cadmium-0.5% copper, lead, lead-0.5% silver, zinc, zinc-1% iron, 99.993% iron, cast iron, Armco iron, and duralumin.—NSA.

3.8 Miscellaneous Principles

3.8.3, 2.3.9

Study of Some Electrochemical Phenomena by Means of an Electrical Weighing Device. (In Italian.) Paolo Spinedi. *Metallurgia Italiana*, **44**, 109-116 (1952) Mar.

Passivation behavior of nickel, tin, and silver was studied. In the case of nickel it was found that variations in the exposed surface of the test bars examined results in a characteristic surface critical parameter curve. For tin, the curves obtained show how the passivation process is influenced by the valence state in which the element dissolves in the etching medium under the action of an applied emf. As to the silver, according to the results obtained, it is anodically oxidized by a mechanism which leads to very slight modifications of the critical parameters.—BTR.

3.8.3, 3.5.12

Effect of the Magnetic and Sonical Fields on the Anodic Passivation of Pure Iron. Y. Ogawa, Y. Hisamatsu, A. Moriya. *J. Japan Inst. Metals*, **16**, No. 4, 194-197 (1952) April.

Effects of the magnetic and sonical fields on the anodic passivation of pure iron in 1 normal-nitric acid and 2 normal-sulfuric acid were studied.

Results obtained are as follows: 1) In the magnetic field perpendicular to the anode plate, the passivation was retarded, while in the weak field parallel to the anode it was accelerated. 2) The sonical field used in the present experiment retarded the γ-Fe_2O_3 passivation and suppressed the Fe_3O_4 passivation. 3) Both

AT LAST! AN ECONOMICAL, SHOCK RESISTANT INSULATING COUPLING

Until recently mechanical weakness and high costs have discouraged the large-scale use of insulating couplings on gas distribution systems. Now comes PESCO . . . *safe*, economical, rugged, easy to install, and assuring permanent electrical insulation.

Insulate your distribution system with

PESCO INSULATING COUPLINGS

PESCO couplings are designed and built to stand up under all types of extreme operational conditions. They are molded of nylon under high pressure. Nylon is a thermoplastic resin which is comparable to thermo-setting resins in physical properties and far superior in chemical resistance and the ability to withstand *bending, side thrust and shock.* They stand pressures up to 1100 psi in the ¾" and 1" sizes and are not affected by temperatures up to 300°F. Molding forms perfect threads and a "di-electric wall" inside the coupling to provide fool-proof electrical insulation and added sealing ability. A special locking device prevents the coupling from turning or slipping in its steel sleeve.

PESCO couplings may be installed by your regular workmen with their standard operating procedures. Available in all sizes from ¾" to 2".

PLASTIC ENGINEERING AND SALES CORP.

P. O. BOX 1037 FORT WORTH, TEXAS

magnetic and sonical field, which are so strong as to retard the passivation fairly, make the passive films (γ-Fe_2O_3) resistant to dilute nitric acid.—JSPS.

3.8.3, 4.3.2, 6.2.2

Active State and Spontaneous Repassivation of Electrically Activated Iron in Nitric Acid. (In German.) KLAUS J. VETTER. *Z. Elektrochem.*, **56**, 106-115 (1952) Feb.

Discussion is based on use of oscillography to determine minimum, maximum, and stationary potential in the active state; potential of the critical point at repassivation; and related times as functions of type of iron, nitric acid concentration, nitrous acid concentration, persistent cathodic current density, stirring, temperature, and Fe-ion concentration. Tables and graphs. 45 references.—BTR.

3.8.3, 6.2.2, 4.3.2

Coating of Freshly Passivated Iron and Its Relationship to Refractory Properties. (In German.) KLAUS J. VETTER AND HANS-JURGEN BOOSS. *Z. Elektrochem.*, **56**, 16-19 (1952) Jan.

The black coating formed during the passivation of iron with HNO_3 increases in thickness and blackness with carbon content. Experiments showed the coating to be Fe_3C and that refractoriness decreases because of the reducing action of this carbide. Data are tabulated and graphed.—MR.

3.8.4

The Kinetics of the Reaction of Germanium and Oxygen. RICHARD B. BERNSTEIN AND DANIEL CUBICCIOTTI. *J. Am. Chem. Soc.*, **73**, No. 9, 4112-4114 (1951).

Oxidation kinetics for germanium do not conform to any previously observed rate law for metal oxidations, but follow an equation of the form $Q = Q^{\infty}[1 - \exp(-kt)]$, where Q is the amount of oxygen consumed in time, t, and k is a temperature dependent constant; Q^{∞} represents the total oxygen consumed over long periods, and varies approximately inversely to the oxygen pressure in the range 2-40 cm. Hg. A mechanism is proposed in which the oxidation rate is controlled by the rate of evaporation of the initial layer of germanium monoxide which is in turn affected during the reaction by the formation of an impervious film of germanium dioxide.—MA.

3.8.4, 6.4.2, 3.6.5, 4.3.3

Solution Kinetics of Aluminum in Sodium Hydroxide. (Sulla cinetica di dissoluzione dell'alluminio in idrato sodico). G. P. BOLOGNESI. *Alluminio* (Italy), **21**, No. 1, 27-41 (1952) Mar.

By measuring the hydrogen generated in the reaction $NaOH + Al + Hg$, the solution speeds of 99.5 and 99.9 percent aluminum in sodium hydroxide, have been determined. Different concentrations of sodium hydroxide were used —from 0.1N to 10N. The results which were obtained indicate that mercury, in a weak solution of sodium hydroxide (0.1 N for 99.5 percent purity aluminum up to 5 N for 99.99 percent purity) inhibits the reaction. With higher concentrations (1-9 N for 99.95 percent and above 5 N for 99.99 percent) aids the hydrogen generation. The solution potentials were determined as a function of the mercury content by measuring the amount of hydrogen generated, and calculating the weight losses to the cathode and anode by applying an electromotive force to two 99.5 percent aluminum electrodes in a sodium hyrdoxide solution (0.2 N), both with and without mercury present. (Author's summary.)—ALL.

3.8.4

Thermodynamic Study of Iron-Oxygen-Sulfur System; Annual Report. F. J. DUNKERLEY, J. L. NICHOLS, and V. V. DAMIANO. Towne Scientific School, Univ. of Pa. Oct 1, 1951, 7p.

Progress is reported in the thermodynamic study of the iron-sulfur-oxygen system. Preliminary results show that when sulfur dioxide having a partial pressure of 9.032×10^{-5} atm. is passed over molten iron having a high sulfur content (0.401%), an increase in reaction is observed with increasing temperatures. A plot of

$$\frac{(FeS)\,(FeO)^2}{PSO_2}$$

vs 1/T gives a straight line indicating a constant heat of reaction in this temperature range.—NSA.

3.8.4, 3.2.3, 6.2.2

On the Mechanism and Kinetics of the Scaling of Iron. M. H. DAVIES, M. T. SIMNAD, and C. E. BIRCHENALL. Carnegie Inst. Tech. Paper before Am. Inst. Mining & Met. Engrs., Detroit Mtg., Oct. 1951. *J. Metals*, **3**, No. 10, (Trans. Am. Inst. Mining & Met. Engrs.) 889-896 (1951) Oct.

The transport mechanisms previously proposed in wüstite and hematite have been confirmed by movement of inert markers during the growth of these phases. By similar measurements the mechanism for magnetite was determined. The rates of growth of multilayer scales on iron, magnetite and hematite on wüstite, and hematite on magnetite have been measured. All rates are found to be diffusion controlled under the conditions of the experiment. Graphs and tables of the results and 32 references are given. —INCO.

3.8.4, 3.4.6

The Kinetics of the Oxidation of Iron (II) By Bromine. PAUL R. CARTER and NORMAN DAVIDSON. Gates and Crellin Labs. of Chemistry, Calif. Inst. of Tech. (no date) 22p. (AECU-2026; Contribution No. 1662).

The kinetics of the oxidation of iron (LL) by aqueous bromine has been investigated spectrophotometrically at an ionic strength of 1.00 maintained with sodium ions and perchlorate ions. The rate law is given. The probable mechanism is 1) $Fe^{++} + Br_2^- \rightleftharpoons Fe^{+3} + Br^-_2 + Br^-$ and 2) $Fe^{++} + Br_2^- \rightarrow Fe^{+2} + 2Br^-$. The inhibition of ferric ion is strong evidence for this reaction path and eliminates an alternate path involving iron (IV) as the unstable intermediate. The available thermodynamic estimates give for reaction 1) $\Delta F^\circ_{298} = 8.8$ k cal, $\Delta H^\circ_{298} = 1.0$. Additional terms in the rate law which apply in the presence of hypobromous and phosphoric acids are given.—NSA.

3.8.4, 3.4.6

Periodic Phenomena in the Corrosion of Metals by Vapors. (In French.) R. DUBRISAY. *Bull. soc. chim. France*, 1058-1060 (1950) Nov.-Dec.

When a thin sheet of silver or copper with a small hole in it is placed over a test tube containing a fragment of iodine, concentric colored rings form around the hole, due to decreasing thickness of iodine formed at increasing distances from the hole. A quantitative study was made of this phenomenon for various periods of time and temperatures up to 70° C. Effects of various factors are thoroughly analyzed. Data are tabulated and charted.

3.8.4, 3.5.9

The Kinetics of the Reduction of Iron Oxide Above 1400° C. T. E. DANCY. *J. Iron Steel Inst.*, **169**, Pt. 1, 17-24 (1951) Sept.

An apparatus has been developed for the study of the rapid reduction of FeO and Fe_3O_4 by carbon in molten pig iron. Oxide attack of the refractory was prevented by using a spinning crucible, and the reaction was followed by cinematographic recording of a low-inertia pressure gauge. The apparent activation energy of the reduction of FeO is —43,100 cal./mol, and of Fe_3O_4 is —37,300 cal./mol. The FeO reduction behaved as if of the first order, but only the initial part of the Fe_3O_4 reduction behaved thus. Temperature coefficients determined from activation energy and from order of reaction curves showed reasonable agreement. Graphs, tables and 9 references. —INCO.

3.8.4, 3.6.5

Liquid-Liquid Junction Potentials of Some Solutions of Copper-Salts at Different Temperatures. (In French.) M. BONNEMAY and J. FAIRBANK. *J. recherches centre natl. recherche sci. Labs. Bellevue (Paris)*, No. 17, 66-68, (1951) Dec.

Describes theoretical considerations. Experimental data are tabulated.—BTR.

3.8.4, 3.8.2, 5.8.1, 3.5.9

Dry Oxidation and Wet Corrosion. U. R. EVANS. *Nature*, **168**, 853-855 (1951) Nov. 17.

Presents an interpretation of the above phenomena. Attempts to show that they are not wholly disconnected on the basis that alloying constituents added to combat the former often prevent the latter. Discusses high-temperature oxidation, oxygen in wet corrosion, electrochemical mechanisms, inhibitors, effects of sulfur and impurities. 19 references.—BLR.

3.8.4, 4.3.2

Laws Governing Rate of Solution of Metals in Concentrated Acids. I. (In Russian.) YA. V. DURBIN. *J. Gen. Chem.* (U.S.S.R.) (Zhurnal Obshchei Khimii), **21**, No. 83, 801-808 (1951) May.

The cause of a maximum on the rate vs. concentration curves for metals in concentrated acids, and lack of connection with the maximum on electroconductivity vs. concentration curves. Solution of chromium in hydrochloric acid was studied as an example. Reactions at the metal surface at different concentrations were found to be determining factors in rate of solution. 15 references.—MR.

3.8.4, 6.3.15, 3.5.9

Oxidation of Titanium. M. H. DAVIES and C. E. BIRCHENALL. (Carnegie Inst. Tech.) Paper before Am. Inst. Mining & Met. Engrs., Detroit Mtg., Oct. 1951. *J. Metals*, **3**, No. 10 (Trans. Am. Inst. Mining & Met. Engrs.) 877-880 (1951) Oct.

The rate of oxidation of titanium in the temperature range 650-950° C was measured. The linear rate law obtained is explained by interface reaction control of the process. Tracer experiments indi-

cate the oxygen diffuses in at least 1 phase of the scale. Graphs and tables of the results and 14 references are given. —INCO.

3.8.4, 1.6

Tables of Chemical Kinetics, Homogeneous Reactions. National Bureau of Standards Circular 510. (1951) xxiv. 731 pp. Government Printing Office, Washington 25, D. C. $4.00.

This circular presents a critically evaluated compilation of the available numerical data on rates and rate constants of homogeneous chemical reactions. Stress is laid throughout on experimentally ascertained facts, and data depending on interpretations are generally not included.

Supplementary tables give additional useful numerical information. References are usually provided for secondary effects, in particular the great variety of salt effects, etc. In addition, the circular contains a list of references to literature in the field and some concise comments on a variety of additional items of information, both on the table as a whole and on particular reactions.

The tables presented in the present volume are a cooperative effort sponsored by the National Bureau of Standards, the Committee on Table of Constants of the National Research Council, and Princeton University. These and other scientific organizations are working together to compile separate critical tables of data in selected fields in which the need is apparent and there are available experts thoroughly familiar with the subjects to undertake the work.

3.8.4, 3.5.3, 7.2, 2.1.1

Erosion Due to Particle Impingement Upon Bends in Circular Conduits. R. V. BAILEY. Oak Ridge National Lab. Issued Nov. 21, 1951, 17 pp. (ORNL-1071).

A qualitative analysis, based on a number of assumptions, has been made of the erosion caused by small solid particles impinging upon a bend in a circular conduit. The resulting equation is

$$E = \text{Const.} \frac{U_{av}^{3.8}\, r\,(\rho_s - \rho_e)}{\mu R\, \rho_s^{0.6}} \left[1 + \frac{U_{av}^{2}\,(\rho_s - \rho_e)^{2.8}\, r^{5.6}}{68\mu^{2.8} R^{2.8}} \right]$$

where E is the weight loss of conduit per pound of particles, U_{av} is fluid velocity, r and R are radius of particle and of bend, ρ_s and ρ_e are density of solid and liquid, and μ is viscosity.—NSA.

3.8.4, 4.2.5, 4.6.11

The Chemistry of Marine Corrosion. C. H. BLAIR. U. S. Navy. *J. Am. Soc. Naval Engrs.*, **64**, No. 1, 121-126 (1952) Feb.

Explains the theory of corrosion of metals and shows how a knowledge of this theory can be put to practical use. Discusses galvanic action, couples and plating. Table lists a number of noncorroding metals such as Monel and stainless steel with the approximate composition and some of the important properties.—INCO.

3.8.4, 4.7

Friction and Surface Damage of Several Corrosion-Resistant Materials. M. B. PETERSON AND R. L. JOHNSON. National Advisory Committee for Aeronautics. Research Memorandum, No. E51L20 (1952) Feb. 20.

An investigation, in air, of several materials that are resistant to corrosion by liquid metals. The values of kinetic friction coefficient at low sliding velocities and photomicrographs of surface damage were obtained. Appreciable surface damage was evident for all materials tested except tungsten carbide. The friction coefficients for the combinations of steel, stainless steel, and Monel sliding against steel, nickel, Inconel, and Nichrome ranged from 0.55-0.97. Nickel in all tests conducted had high friction coefficients approaching 1, except against tungsten carbide. Welding was apparent at all loads. The friction coefficients for Nichrome and Inconel were lower than for nickel with all combinations of slider material. This may be the result of the increase in hardness of these alloys. Illustrations are included.—INCO.

3.8.4, 6.3.13, 2.3.9

A Spectrophotometric (and Microgravimetric) Study of the Oxidation of Tantalum. J. T. WABER, G. E. STRUDY, AND E. M. WISE. *J. Electrochem. Soc.*, **99**, No. 3, 121-129 (1952) March.

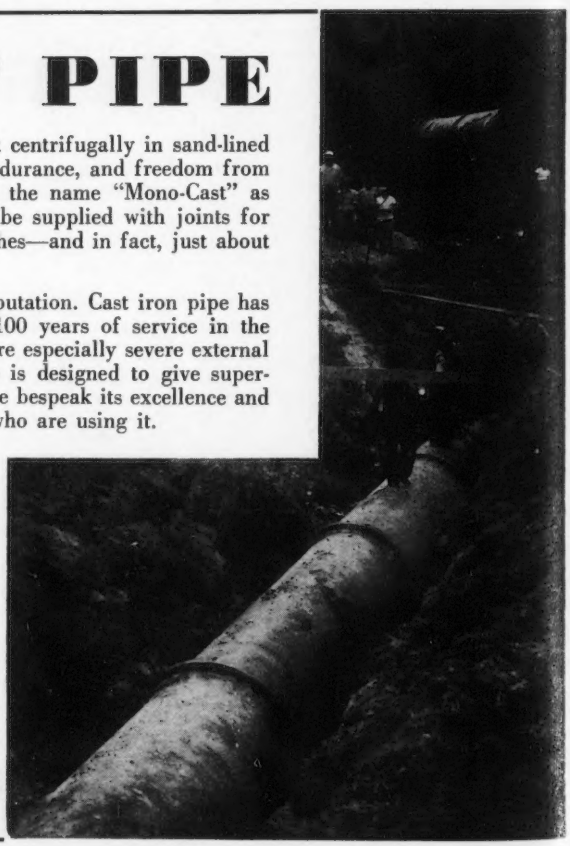
Comparative measurements of the oxidation of tantalum in air at 220°-350° C. Up to 320° C, a logarithmic law was obeyed and resistance to oxidation was good, the scale being highly adherent despite frequent heating cooling. Above 320° C, a parabolic law may be obeyed. A note added in proof states that X-ray evidence indicates that a phase other than tantalum and tantalum oxide is present in products formed at or below 300° C.—BNF.

MONO-CAST PIPE

"Mono-Cast" is the trade name for ACIPCO pipe cast centrifugally in sand-lined molds. Uniform metal section, high physical strength, endurance, and freedom from inclusions are salient properties which have established the name "Mono-Cast" as synonymous with highest quality cast iron pipe. It can be supplied with joints for conveying water, gas, oil, gasoline, sewage, salt brine, ashes—and in fact, just about everything that a pipe line can conceivably convey.

Being cast iron Mono-Cast Pipe enjoys an enviable reputation. Cast iron pipe has had over 300 years of service abroad and more than 100 years of service in the United States. It is satisfactorily serving in locations where especially severe external and internal corrosion conditions exist. Mono-Cast Pipe is designed to give superservice; and its wide acceptance and splendid performance bespeak its excellence and the confidence and esteem in which it is held by those who are using it.

For many years our Company has pioneered in research, maintaining an experienced staff of chemists, metallurgists, engineers, and fully equipped modern laboratories. Refer your next piping problem to ACIPCO and utilize our extensive manufacturing facilities.



AMERICAN
CAST IRON PIPE
COMPANY

Birmingham 2, Alabama

Johns-Manville TRANTEX *polyvinyl* TAPE

gives lasting protection against corrosion

YOU CAN MAKE emergency repairs quickly and economically right in the field with Johns-Manville Trantex Tape. This pipeline protective material is especially suitable for repairing damage to enamel coatings or holidays in coatings.

Trantex is recommended for field coating the joints of mill wrapped pipe. It also has many advantages for coating lateral lines and short runs where heavy duty coating equipment is not available. Save on emergency coating repairs too, by keeping a supply of Trantex in your warehouse for rush requirements.

Trantex Tape is easily applied by hand or simple wrapping devices. It is a durable plastic, cold-applied tape, with a pressure sensitive adhesive that sticks on contact, bonds tightly to enamel coatings or bare or primed steel. Trantex Tape provides uniformly high electrical resistance.

J-M Asbestos Pipeline Felt is a durable shield for pipe line enamels. Proven in use for protecting enamel coating from cold flow under stress. It often is applied over Trantex Tape, for extra protection in rocky areas. Rotary type wrapping machines apply the felt and Trantex Tape in one operation.

For more details write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ont.

PROPERTIES OF TRANTEX TAPE

	*V-10	**V-20
Dielectric Strength per mil thickness Approx.	1,000 V	1,000 V
Insulation Resistance, greater than (ASTM-D-257-49)	100,000 megohms	100,000 megohms
Temperature Limit	200 F	200 F
Adhesion oz. per inch width	30	20
Tensile Strength lbs. per inch	30	56
Elongation at Break	250%	300%

"Trantex" is a black polyvinyl tape. It is available in two thicknesses—

*V-10 is a 10 mil tape for average conditions, and

**V-20 is a 20 mil thickness for use where a more rugged coating is specified such as to repair enamel coatings.

JOHNS-MANVILLE PRODUCTS

Johns-Manville TRANTEX *polyvinyl* TAPE

115a

cate the oxygen diffuses in at least 1 phase of the scale. Graphs and tables of the results and 14 references are given. —INCO.

3.8.4, 1.6

Tables of Chemical Kinetics, Homogeneous Reactions. National Bureau of Standards Circular 510. (1951) xxiv. 731 pp. Government Printing Office, Washington 25, D. C. $4.00.

This circular presents a critically evaluated compilation of the available numerical data on rates and rate constants of homogeneous chemical reactions. Stress is laid throughout on experimentally ascertained facts, and data depending on interpretations are generally not included.

Supplementary tables give additional useful numerical information. References are usually provided for secondary effects, in particular the great variety of salt effects, etc. In addition, the circular contains a list of references to literature in the field and some concise comments on a variety of additional items of information, both on the table as a whole and on particular reactions.

The tables presented in the present volume are a cooperative effort sponsored by the National Bureau of Standards, the Committee on Table of Constants of the National Research Council, and Princeton University. These and other scientific organizations are working together to compile separate critical tables of data in selected fields in which the need is apparent and there are available experts thoroughly familiar with the subjects to undertake the work.

3.8.4, 3.5.3, 7.2, 2.1.1

Erosion Due to Particle Impingement Upon Bends in Circular Conduits. R. V. Bailey. Oak Ridge National Lab. Issued Nov. 21, 1951, 17 pp. (ORNL-1071).

A qualitative analysis, based on a number of assumptions, has been made of the erosion caused by small solid particles impinging upon a bend in a circular conduit. The resulting equation is

$$E = \text{Const.}\ \frac{U_{av}^{3.3}\, r\,(\rho_s - \rho_e)}{\mu R\, \rho_s^{0.6}}\left[1 + \frac{U_{av}^{2}\,(\rho_s - \rho_e)^{2.3}\, r^{5.6}}{68\mu^{2.3} R^{2.3}}\right]$$

where E is the weight loss of conduit per pound of particles, U_{av} is fluid velocity, r and R are radius of particle and of bend, ρ_s and ρ_e are density of solid and liquid, and μ is viscosity.—NSA.

3.8.4, 4.2.5, 4.6.11

The Chemistry of Marine Corrosion. C. H. Blair. U. S. Navy. *J. Am. Soc. Naval Engrs.*, **64**, No. 1, 121-126 (1952) Feb.

Explains the theory of corrosion of metals and shows how a knowledge of this theory can be put to practical use. Discusses galvanic action, couples and plating. Table lists a number of noncorroding metals such as Monel and stainless steel with the approximate composition and some of the important properties.—INCO.

3.8.4, 4.7

Friction and Surface Damage of Several Corrosion-Resistant Materials. M. B. Peterson and R. L. Johnson. National Advisory Committee for Aeronautics. Research Memorandum, No. E51L20 (1952) Feb. 20.

An investigation, in air, of several materials that are resistant to corrosion by liquid metals. The values of kinetic friction coefficient at low sliding velocities and photomicrographs of surface damage were obtained. Appreciable surface damage was evident for all materials tested except tungsten carbide. The friction coefficients for the combinations of steel, stainless steel, and Monel sliding against steel, nickel, Inconel, and Nichrome ranged from 0.55-0.97. Nickel in all tests conducted had high friction coefficients approaching 1, except against tungsten carbide. Welding was apparent at all loads. The friction coefficients for Nichrome and Inconel were lower than for nickel with all combinations of slider material. This may be the result of the increase in hardness of these alloys. Illustrations are included.—INCO.

3.8.4, 6.3.13, 2.3.9

A Spectrophotometric (and Microgravimetric) Study of the Oxidation of Tantalum. J. T. Waber, G. E. Strudy, and E. M. Wise. *J. Electrochem. Soc.*, 99, No. 3, 121-129 (1952) March.

Comparative measurements of the oxidation of tantalum in air at 220°-350° C. Up to 320° C, a logarithmic law was obeyed and resistance to oxidation was good, the scale being highly adherent despite frequent heating cooling. Above 320° C, a parabolic law may be obeyed. A note added in proof states that X-ray evidence indicates that a phase other than tantalum and tantalum oxide is present in products formed at or below 300° C.—BNF.

MONO-CAST PIPE

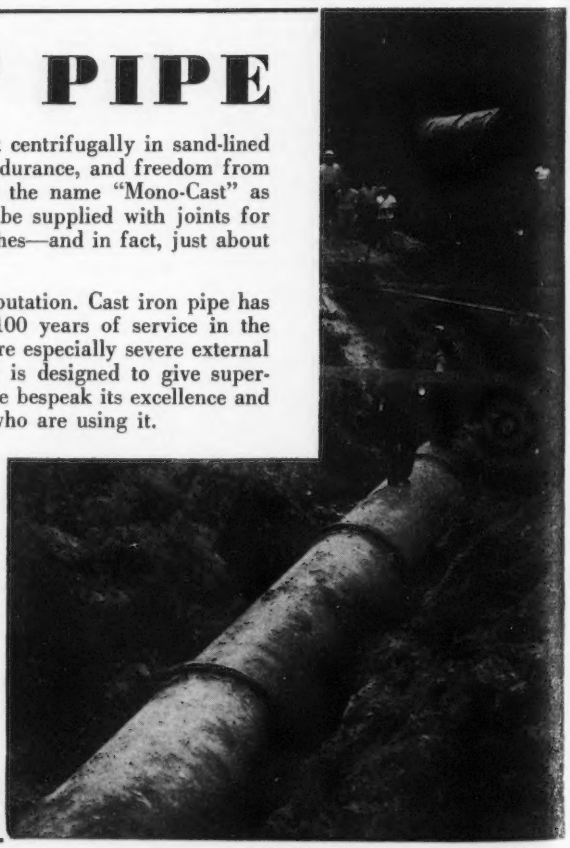
"Mono-Cast" is the trade name for ACIPCO pipe cast centrifugally in sand-lined molds. Uniform metal section, high physical strength, endurance, and freedom from inclusions are salient properties which have established the name "Mono-Cast" as synonymous with highest quality cast iron pipe. It can be supplied with joints for conveying water, gas, oil, gasoline, sewage, salt brine, ashes—and in fact, just about everything that a pipe line can conceivably convey.

Being cast iron Mono-Cast Pipe enjoys an enviable reputation. Cast iron pipe has had over 300 years of service abroad and more than 100 years of service in the United States. It is satisfactorily serving in locations where especially severe external and internal corrosion conditions exist. Mono-Cast Pipe is designed to give superservice; and its wide acceptance and splendid performance bespeak its excellence and the confidence and esteem in which it is held by those who are using it.

For many years our Company has pioneered in research, maintaining an experienced staff of chemists, metallurgists, engineers, and fully equipped modern laboratories. Refer your next piping problem to ACIPCO and utilize our extensive manufacturing facilities.

AMERICAN
CAST IRON PIPE
COMPANY

Birmingham 2, Alabama



Johns-Manville

TRANTEX *polyvinyl* TAPE

gives lasting protection against corrosion

YOU CAN MAKE emergency repairs quickly and economically right in the field with Johns-Manville Trantex Tape. This pipeline protective material is especially suitable for repairing damage to enamel coatings or holidays in coatings.

Trantex is recommended for field coating the joints of mill wrapped pipe. It also has many advantages for coating lateral lines and short runs where heavy duty coating equipment is not available. Save on emergency coating repairs too, by keeping a supply of Trantex in your warehouse for rush requirements.

Trantex Tape is easily applied by hand or simple wrapping devices. It is a durable plastic, cold-applied tape, with a pressure sensitive adhesive that sticks on contact, bonds tightly to enamel coatings or bare or primed steel. Trantex Tape provides uniformly high electrical resistance.

J-M Asbestos Pipeline Felt is a durable shield for pipe line enamels. Proven in use for protecting enamel coating from cold flow under stress. It often is applied over Trantex Tape, for extra protection in rocky areas. Rotary type wrapping machines apply the felt and Trantex Tape in one operation.

For more details write Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay St., Toronto 1, Ont.

PROPERTIES OF TRANTEX TAPE

	*V-10	**V-20
Dielectric Strength per mil thickness Approx.	1,000 V	1,000 V
Insulation Resistance, greater than (ASTM-D-257-49)	100,000 megohms	100,000 megohms
Temperature Limit	200 F	200 F
Adhesion oz. per inch width	30	20
Tensile Strength lbs. per inch	30	56
Elongation at Break	250%	300%

"Trantex" is a black polyvinyl tape. It is available in two thicknesses—

*V-10 is a 10 mil tape for average conditions, and

**V-20 is a 20 mil thickness for use where a more rugged coating is specified such as to repair enamel coatings.

JM PRODUCTS **Johns-Manville TRANTEX *polyvinyl* TAPE**

115a

3.8.4, 6.3.13, 6.3.15

On the Cubic Law of Oxidation. JAMES T. WABER. Los Alamos Scientific Lab. (no date) 9p. (AECU-1830; LADC-1083).

The existing information on the cubic law of oxidation of metals is summarized, and new data obtained with tantalum and titanium are presented which indicate that the law may have a greater range of applicability than has been expected.—NSA.

3.8.4, 6.3.15, 3.5.9

The Logarithmic Growth Law for the Oxidation of Titanium. J. T. WABER, G. E. STRUDY, AND E. M. WISE. Los Alamos Scientific Lab. (no date) 14 pp. (AECU-1790; LADC-1050).

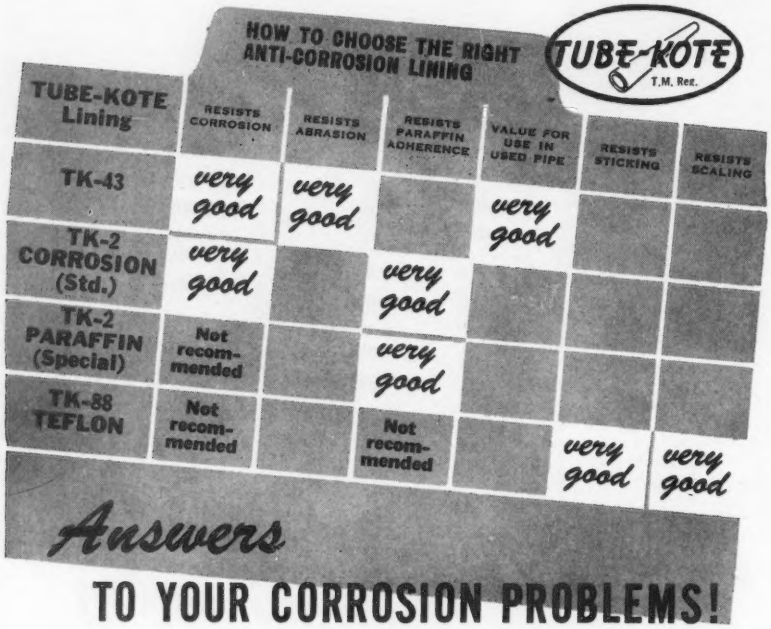
Oxidation of titanium below 350° C was found to follow the logarithmic growth law, as reported by Alexander and Pidgeon, *Can. J. Research*, **28**, (B), 60-72 (1950). The break in the Arrhenius plot, reported by Gulbransen and Andrew, *J. Inst. Metals*, **75**, 741 (1949) is due to the change from the logarithmic to the parabolic rate law at temperatures increasing above 350° C.—NSA.

3.8.4, 6.3.19, 4.3.5

The Kinetics of the Dissolution of Zinc in Aqueous Iodine Solutions.—I.—II. L. L. BIRCUMSHAW AND A. C. RIDDIFORD. *J. Chem. Soc.*, 598-603; 1490-1493 (1951) Feb., June.

I. The following factors affecting the dissolution of zinc in aqueous iodine solution were studied: a) surface area of the zinc; b) method of preparing the zinc surface; c) temperature; d) initial iodine concentration; e) initial concentration of the acid. The rate of dissolution is of 1st. order with respect to the iodine concentration and varies with the apparent surface area of zinc; it is unaffected by the method preparing the surface (with the exception of rouge polishing), and independent of the initial concentration of sulfuric acid (N/100-N/800). The experimental energy of activation is 3790 cal./mole at 25°-45° C.

II. The effects were also investigated of f) varying the potassium iodine concentration; g) varying the value of η by sucrose addition; and h) replacing potassium iodide by other iodides. Increasing the potassium iodide concentration produced a sharp increase in the rate of zinc dissolution. This is comparable with the increase in the coefficient of diffusion of iodine under the same conditions. It is concluded that the overall rate of reaction between zinc and aqueous iodine solution is at least partly determined by the rate of transport of iodine to the zinc surface, but is independent of the rate of recession of products from the surface. —MA.



TK-43: a thick baked-on, rubber-like lining of polyvinyl chloride, centrifugally cast in one coat. **TK-2 CORROSION (Std.):** a 10-coat application of baked-on phenol formaldehyde plastic. **TK-2 PARAFFIN (Special):** a 5-coat application of specially compounded baked-on phenol formaldehyde plastic. **TK-88 TEFLON:** a high-temperature anti-sticking coating material known as polytetrafluorethylene.

TUBE-KOTE

First Name In Corrosion Resistance

Just off the press: New complete data bulletin on TK-43. Write for your copy.

Tube-Kote, Inc.
P. O. Box 20037, Houston 25, Texas

Please send me full details on your products.

Name_____

Firm_____

Street_____

City_____ State_____

116a

4. CORROSIVE ENVIRONMENTS

4.3 Chemicals, Inorganic

4.3.2, 6.2.3, 3.8.4

Influence of the Concentrations of Acids on their Corrosivity in Relation to Carbon Steels. (In Russian.) S. A. BALEZIN AND T. I. KRASOVITSKAYA. *J. Applied Chem.* U.S.S.R. (Zhurnal Prikladnoi Khimii), **24**, No. 2, 197-202 (1951) Feb. Summary translation in *Ind. and Eng. Chem.*, **43**, No. 12, 75A, 76A, 78A (1951) Dec.

Authors found that the rates of dissolution of carbon steels in acids were proportional to a^n, where 'a' is the activity of the acid and 'n' a constant having the values of 0.67 for sulfuric acid, 0.85 for hydrochloric acid, 0.38 for acetic acid.—BNF.

4.4 Chemicals, Organic

4.4.3, 6.4.2

Corrosion of Aluminum by Alcohols. J. P. BALASH AND E. D. VERINK, JR. *Chemical Engineering*, **58**, No. 11, 302-305 (1951) Nov.

Aluminum alloys are suited for service with most of the commercial alcohols. Chemical equipment and shipping containers made of aluminum are extensively employed for industrial and beverage alcohols. At room temperature most commercial alcohols are without effect on aluminum. At elevated temperatures, aluminum is normally suitable provided a trace of moisture is present. With the addition of an inhibitor even those alcohols which contain heavy metals or other contaminants generally can be handled in aluminum. Aluminum alloys may be employed for alcohols produced both by the grain fermentation process and petroleum gas synthesis. For fermentation processes, aluminum has the advantage in that it is non-toxic to living organisms, which has encouraged the use of aluminum for the production of citric and gluconic acids, penicillin and other antibiotics. Practically

COATINGS OF VINYLITE BRAND RESIN

with the give that can take it!

FLEXIBILITY is a must when formulating coatings for milk processors and other equipment subject to rapid heating and quick cooling.

Such frequent wide temperature changes are rough on ordinary paints. However, coatings based on VINYLITE Brand Resins just move with the metal, expanding and contracting the amount needed . . . adhering tenaciously.

Moreover, they are highly wear-resistant, and can take the constant washing and scrubbing required in food plants, and the scuffs and bumps of people, tools and equipment. VINYLITE Resin coatings are highly chemical-resistant . . . unaffected by most detergents, chlorine solutions, acids and alkalies. And, they can be colored to practically any shade or deep tone desired for product identification or equipment coding.

No matter what you coat—dairy equipment, tank cars, oil refineries, marine installations, chemical plants—VINYLITE Resin coatings bring outstanding results wherever surfaces are exposed to rough treatment, chemicals, salt water, industrial gases. Properly applied, they stay put on metal, concrete, masonry without cracking, chipping, peeling or fading.

You can improve performance as well as cut costs by using coatings based on one of the many BAKELITE or VINYLITE Resins. Write Dept. QF-69 for folder giving case histories of severe coating applications.

Photo shows milk plant equipment made by Cherry-Burrell Corporation, Chicago 6, Ill., and coated with VINYLITE Resin coatings in Cherry-Burrell Blue. Coatings were prepared by Stoner-Mudge, Inc., Pittsburgh 33, Pa.

Case Histories Prove Performance

BAKELITE Resin Floor Varnish—Floor finishes based on BAKELITE Resins provide extreme wear resistance that minimizes maintenance costs. A typical case history has been the gymnasium floor of the Sewickley (Pa.) High School—subject to rough daily service from basketball and other events—even school dances. Yet, four years after being coated with an air-drying varnish based on BAKELITE Resin, it still maintained its lustrous surface. No touch-up had been needed, either. And, the stripes and markings applied before the BAKELITE Resin coating were just as sharp and new-looking as when applied.

Special-purpose Industrial Coatings—*Very few industrial coating problems are identical. Minute changes in formulations can make a tremendous difference in satisfaction. Coatings for water purification units are an excellent example. Here, a specially-formulated BAKELITE Resin baking system provided not only the protection normally required for metal equipment, but also protected pipes and tanks against electrical leakage and the corrosive action of ozone.*

VINYLITE Resin Coatings for Railway Equipment—Normal service conditions are tough enough on industrial coatings! Add the problems that railroad freight cars bring.. vibration, weather variations, pounding with sledge hammers to loosen loads . . . and it takes top performance for a coating to stand up. Despite this rough and tough treatment, freight cars of the Illinois Central Railroad, protected with VINYLITE Resin coatings, took this treatment plus rain, heat, cold, sun, corrosive loads and fumes for *over six years*—and the coatings were *still in good condition!*

Structural Finishes for Corrosion-Erosion Resistance—*Another example of how well BAKELITE Resins solve difficult coating problems was the painting of structural steel work on river locks and dams in the Monongahela River. Acid pollution and flow of silt had developed a serious combination of costly corrosion and erosion. Reports stated "ordinary paints are of little value in preventing corrosion and erosion under the conditions described." After seven years' research and testing, the engineers in charge determined that pigmented BAKELITE phenolic resin coatings were superior to any other for this use.*

BAKELITE TRADE-MARK
AND Vinylite BRAND
RESINS
TRADE MARK

BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd St., New York 17, N. Y.

117a

all types of aluminum brewery equipment, brew kettles, starters, fermenters, storage tanks, and government tanks have been used in the United States since 1934.—ALL.

4.4.8, 4.4.6, 6.2.1, 6.6.8, 6.3.6

Urea Extractive Crystallization of Straight-Chain Hydrocarbons. W. A. BAILEY, JR., R. A. BANNEROT, L. C. FETTERLY, AND A. G. SMITH, Shell Oil Co. *Ind. & Eng. Chem.*, **43**, No. 9, 2125-2129 (1951) Sept.

Construction of the pilot plant can be of mild steel throughout, except that stainless steel is preferred for sofe of the filter parts. The tendency of urea solution to corrode steel in the presence of air was overcome by the addition of an inhibitor, preferably ammonium chromate. Copper-bearing metals must be avoided as they are attacked by urea and by the ammonia formed as a hydrolysis product. Rubber and many types of plastic materials are weakened or dissolved by the ketone solvent; therefore gasket and hose materials must be specially selected. Polythene and Teflon were used in many locations in the pilot plant.—INCO.

4.6 Water and Steam

4.6.2, 5.7.8, 5.8.2

The Preparation of Distilled Water as Boiler Feed Water. C. H. ALLEN. Paper before Soc. Chem. Ind., Sym. on Distillation, London, April 3, 1950. *Chemistry & Industry*, No. 37, 772-774 (1951) Sept. 15.

Method used at Plaistow Wharf Refinery for softening of water required for evaporation is the lime-soda-sodium aluminate process, precipitating the scale forming salts of calcium and magnesium. After filtering, the evaporators are protected from corrosion by removal of oxygen by deaeration and the use of sodium sulphite. The general method of inhibiting caustic embrittlement is by maintaining an optimum ratio of sodium sulphate to sodium hydroxide. Graph and diagrams are included. 3 references. —INCO.

4.6.3, 8.4.3, 3.5.3, 3.6.2

Cities Service Tackles Brackish-Cooling-Water Corrosion. J. J. PICARAZZI, Cities Service Refining Corp. *Oil & Gas J.*, **50**, No. 45, 271-272, 274, + (1952) May 17.

Corrosion by brackish cooling water is one of the most serious problems found in the operation of the Tutwiler Refinery of Lake Charles, La. Intermittent chlorination is practiced to control aquatic growths in the water system and it has been a very important factor in condenser-tube life. River water pumps with cast iron impellers were replaced with bronze when necessary. Steam surface condensers were equipped with Muntz metal tube sheets and others with rolled steel while water boxes were of Admiralty and Muntz metal. Where service life with Admiralty was poor, 70-30 copper-nickel was used. High velocities of water flowing through the tubes led to impingement attack and low velocities caused concentration-cell corrosion. Illustrations are given.—INCO.

4.6.6, 6.3.6, 7.2

The Effect of Chlorination of Drinking Water on Brass Fittings. C. A. RISBRIDGER. *J. Inst. Water Eng.*, **6**, No. 1, 65-73 (1952) Feb.

Summarises results of tests by P. D. Crowther (Peglers Ltd.) on brasses used for ball valve seats. Although findings of Ingleson, Sage and Wilkinson are in general supported, it was concluded that free chlorine increases attack on cast alpha brass as well as on hot pressed alpha-beta brass. Difference in results discussed in light of differences in testing techniques employed.—BNF.

4.6.11, 4.2.5, 3.3.2, 5.1

Marine Attack. CLYDE WILLIAMS. *Monthly Business Review*, **34**, 10 (1952) Feb.

Discusses the above problem. Describes recent research methods for determining extent of attack by marine organisms, and salt-water corrosion of metals and alloys, including processes devised for counterattack. Protective measures under study include: introducing copper into wood preservatives, anti-fouling paint, corrosion-resistant alloys, and dehumidification equipment.—BLR.

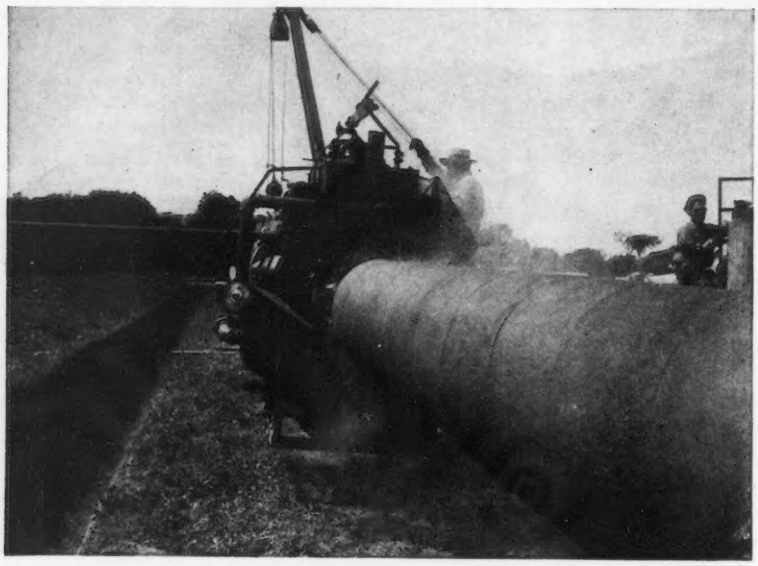
5. PREVENTIVE MEASURES

5.2 Cathodic Protection

5.2.1

Contribution to the Theory of Cathodic Protection. CARL WAGNER. *J. Electrochem. Soc.*, **99**, No. 1, 1-12 (1952) Jan.

The distribution of the electrical potential inside an electrolytic solution is



Wrap Without Traps... Specify

RUBEROID "AIR VENT"

ASBESTOS PIPE LINE FELT

Trapped air, gases and surface moisture that lead to damaging pipe line blisters are eliminated with Ruberoid's new Asbestos Perforated "Air Vent" Pipe Line Felt.

"Air Vent" is made with pin pricks through which air and gases escape during the wrapping process. After wrapping, hot enamel fills the voids. When it cools, it hardens and produces the action of miniature rivets between pipe and felt. The perforations give "Air Vent" added flexibility, too, enabling the felt to grip the pipe much tighter.

National Sales Agents
S. D. DAY COMPANY
1973 West Gray Ave.
Houston 19, Texas
"Serving All Pipe Lines"

You get all these advantages in a pipe line felt that costs you no more. So write for your free sample, today. Pipe Line Felt Dept., The Ruberoid Co., 500 Fifth Ave., N. Y. 36, N. Y.

The RUBEROID Co.

ASPHALT AND ASBESTOS BUILDING MATERIALS

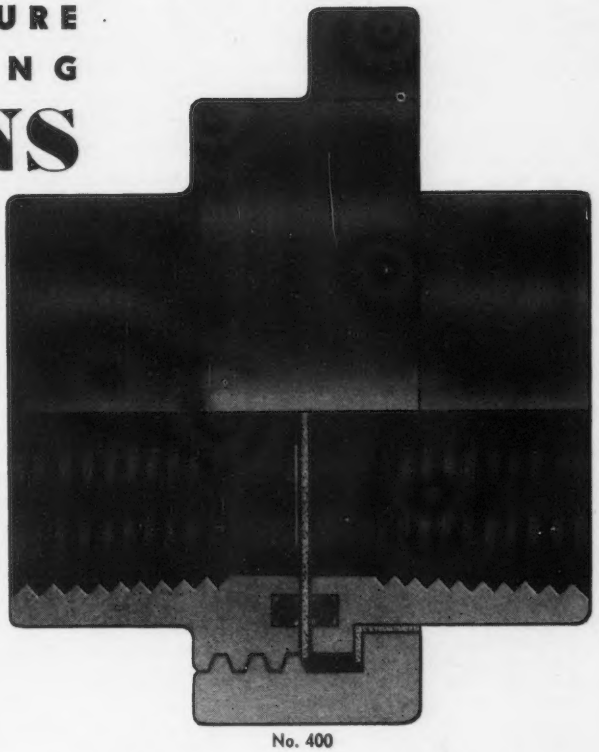
118a

gives best electrical insulation at lowest cost to you—

B-K HIGH PRESSURE INSULATING UNIONS

MANUFACTURED BY

YALE MACHINE WORKS



No. 400

B-K high-pressure insulating unions provide an economical means of breaking up the flow of electrolytic current from christmas tree to pipe line system. Developed in recent months they have passed detailed laboratory tests and analyses.

This insulating union employs the "O" ring principle of high-pressure sealing, with insulating gaskets between the faces of the union and around the base of the hammer lug section.

The unions are obtainable in sizes ¼-inch to 10 inches and from 1000 pounds test pressure to 6000 pounds test pressure.

LOW IN COST

Generally speaking, it is possible to save ½ to 2/3 on your insulating cost over conventional flanges, studs and insulating sets.

IN USE BY MAJOR COMPANIES

Practically every major company has approved use of the Brance-Krachy Yale Type Insulating Unions for preventing passage of electrolytic current in flow lines, isolating cathodic protection systems and separating dissimilar metals in oil, gas, water and steam service.

OTHER B-K PRODUCTS

• Special Cathodic Protection Cable • Instruments • Pipe Locators
• Rectifiers • Nylon Insulating Bushings • Cathodic Protection Supplies

COMPLETE CATHODIC PROTECTION EQUIPMENT — B K

Brance-Krachy Co. INC.

4411 NAVIGATION • P.O. Box 1724 • HOUSTON

For Full Information, Write, Wire or Teletype (HO-561)
4411 NAVIGATION BLVD., P. O. BOX 1724, HOUSTON
2850 E. FLORENCE ST., HUNTINGTON PARK, CALIF.
P. O. BOX 13, UPPER MONTCLAIR, NEW JERSEY
1344 GRISWOLD ST., PORT HURON, MICH.

B-K UNIONS ARE AVAILABLE THROUGH ALL SUPPLY STORES

BRANCE-KRACHY CO., INC.
P. O. Box 1724, Houston, Texas

Please send me details on your high pressure insulating unions.

Name_____
Company Address_____
City_____ State_____

119a

calculated for typical cases of cathodic protection with the aid of an auxiliary metal to be sacrificed. These calculations are used to work out equations and diagrams which permit prediction of the maximum extension of metallic surfaces for which cathodic protection can be accomplished. Decisive factors are a) the electrical conductivity of the corroding solution, and b) the current density for the cathodic reduction of oxidizers present. The latter value is assumed to be determined by the diffusion rate of the oxidizer from the bulk solution toward the metallic surface to be protected. (Author's summary.)—ALL.

5.2.1, 4.5.2, 8.9.3

Is Cathodic Protection Justified on Lines With Superior Coating? M. E. PARKER. *American Gas J.*, **176.** 14-15, 42 (1952) Mar.

Refers to underground pipelines. Corrosion engineers answer above question in the affirmative, even if the soil traversed is only mildly corrosive.—BTR.

5.3 Metallic Coatings

5.3.1, 5.4.1, 5.9.4, 1.6

Finishing Handbook and Directory 1952 Ed. W. J. ROBERTS. Sawell Publications Ltd., London, E. C. 4. 608 pp.

This year's edition has been greatly enlarged as compared with 1951. The section on painting processes has been doubled in length and new sections deal with vitreous enamels, galvanizing and other zinc coating processes, metal colorings, marking processes etc. That on vitreous enamels contains a number of references to the use of zinc oxide as a constituent of them. Chemical colored finishes for zinc and cadmium are discussed in the section on metal coloring, and solutions for imparting black, grey, brown, green, blue and marbled finishes are described. Thirty-eight pages are devoted to zinc coating processes, viz: hot dip galvanizing, zinc plating, sherardizing, zinc spraying and zinc metal-pigmented paints. The editors have not made very clear the distinction which is drawn between 'cold galvanizing' and 'zinc-metal pigments for painting application.' Hot dip galvanizing is dealt with at some length; pickling, baths, fluxes, withdrawal speeds, metallic additions all being mentioned. The directory section has been expanded to give 3,500 brand names and to list suppliers etc. under some 600 headings. A subject index has been added to facilitate reference.—ZDA.

5.3.1, 8.9.1

Inspection of Electroplated Aircraft Parts. P. SKEGGS. *J. Electro-Depositors Tech. Soc.*, **28,** 15-26 (1952).

The general inspection requirements of D.T.D. specifications covering plating of aircraft parts are outlined. Sampling and methods of testing are dealt with generally, and the particular requirements of certain specifications in more detail. Surface treatment of zinc and cadmium coatings is discussed in the last section. Chromate passivation is stipulated for zinc to enhance the resistance to corrosion, and the method of inspection of the chromate film is outlined.—ZDA.

5.3.2, 1.7.1

Corrosion Resistance of Metallized Steel. ASTM Bulletin, No. 176, 13 (1951) Sept.

The American Welding Society's Committee on Metallizing has organized a test program for testing steel specimens coated with aluminum and zinc coatings. The metal will be sprayed on in varying thicknesses from 0.003 to 0.015 inches, with and without vinyl cover coats. They will be exposed at the various test sites for periods of one, six and twelve years. The types of exposure include sea water, marine atmosphere and the different industrial atmospheres. Examination will be made at intervals and reports issued.—ALL.

5.3.2, 5.3.4

Laminated Aluminum Finish Replaces Nickel-Chrome. W. A. BARTSKI. *Industrial Finishing*, **27,** 44-46, 48 (1951) Aug.

Development of a smooth, lustrous, light-silver gray metallic finish that is baked on and will adhere perfectly to metal surfaces and which has good durability. It is suitable for many protective and decorative uses, including replacement for nickel-chromium plating.—MR.

5.3.2, 5.3.4, 1.3

Development of Fused Metallized Coatings. H. S. SAYRE. U. S. Naval Eng. Exp. Station. Paper before AWS, 32nd Ann. Mtg., Detroit, Oct. 15, 1951. *Welding J.*, **31,** No. 1, 35-39 (1952) Jan.

Review of the investigations conducted in the development of materials, techniques and procedures for the application of fused metallized coatings. In search for satisfactory protective coating for use of low-alloy steels in sea water, nickel, brass, Monel, stainless steel and nickel-chromium-tungsten alloys of various types were applied by metallizing and remelting. A modification of 13-20% chromium 64-75% nickel 3-5% boron alloy used as the overlay material was developed. Salt water immersion tests showed the overlay to be corrosion-resistant and the base metal fully protected. Photographs are included.—INCO.

5.3.2, 5.3.4, 6.2.3

The Protection of Steel by Sprayed Aluminum. W. E. BALLARD. *Electroplating and Metal Finishing (England)*, **4,** No. 12, 395-399 (1951) Dec.

A mechanism is postulated for the formation of the rust stains which sometimes appear on aluminum-sprayed steel, and methods for avoiding the staining are suggested. Should rust stains occur and the surface is wire brushed, no further trouble is usually experienced. Staining is more prevalent when the metal has been sprayed with rapidly-running pistols, using heavy gauge wire or when the coating has been applied carelessly giving a rough deposit. Other factors influencing the formation of stains include the thickness of the coating and its porosity, and the properties of the electrolyte. Coatings may fail by scaling and weakness developed along lines parellel to the base material, that is, the particles applied by spraying may tend to separate. In prevention of staining the use of an aluminum alloy containing about 10 percent zinc will give coatings which are anodic under nearly all conditions. However, the percentage of zinc in the alloy has a tendency to break down the tenuous layer of oxide which protects the aluminum surface. Lacquering the freshly sprayed surface will tend to retard the staining, or finally, spraying the coating with a solution ensuring the setting up of the anodic conditions.—ALL.

5.3.2, 5.4.5, 6.2.1, 5.8.2, 8.9.2

Protection of Ferrous Surfaces Against Corrosion. ERICA ANTINORI. *Tecnica ital.*, **6,** No. 2, 120-126 (1951).

Results are reported of corrosion tests carried out at the FIAT laboratories, Turin. Of nine steel specimens, one was unprotected, four painted, three Ni-coated by the "electroless plating" process, and one coated with a synthetic resin. After exposure in saline vapor, an American strippable plastic paint coating proved most, the synthetic resin least efficient. The best inhibitor against corrosion by cooling liquids in internal-combustion engines was determined to be a mixture of potassium dichromate and sodium carbonate in equal parts.—MA.

5.3.4

Metal Spraying. A. R. OLD. *J. Oil Colour Chemists Assoc.*, **35,** No. 379, 20-27 (1952) Jan.

The author describes the metal spraying process and gives an indication of its scope and applications, and the mechanism of protection against corrosion by metal spraying. Certain practical points (with special reference to the paint industry) are considered. The value of the process for the reclamation of worn parts and for decoration is outlined. Tests have shown that to give a coating life of five years in Sheffield (considered to be one of the worst industrial atmospheres) a thickness of 0.0036 inches of aluminum or a thickness of 0.0029 inches of zinc is required. A number of uses of sprayed zinc coatings are mentioned both in the paper and in the ensuing discussion.—ZDA.

5.3.4, 3.5.9, 6.3.10, 6.2.1

High Temperature Coatings. F. C. SHAW, The Bettinger Corp. *Organic Finishing*, **13,** No. 4, 15-18 (1952) Apr. *Aviation Week*, **56,** No. 23, 30+ (1952) June 9.

Discusses plating processes for depositing a coating of high-temperature protective material. Metal-ceramic combination cermets consist of composites of inorganic substances intimately bonded. The coating permits the use of metals in more plentiful supply. Cleaning of the metals, the pickling procedure, and parts to be dipped, sprayed, or slushed are described. Coatings are being applied on Inconel, Inconel X, Nimonic #75, stainless steels of various types, Hastelloy B, and on mild steels and low alloy metals. Type of application and reports from the fields are considered. Photographs are included.—INCO.

5.3.4, 5.3.3

The Engineering Applications of Electrodeposited Metals. I. W. OSWALD. *Industrial Finishing, (U.K)*, **4,** No. 45, 600-605 (1952) Mar.

Fourteen metals are electrodeposited commercially, although 20 others have been deposited. Zinc and cadmium are important for protecting iron and steel against corrosion on account of their sacrificial corrosion which protects exposed areas. The author discusses the adhesion and hardness of electrodeposits and the limitations of plating as a method for coating.—ZDA.

NO-OX-ID protects

UNDERWATER AND UNDERGROUND

FOR THE BEST POSSIBLE PROTECTION AGAINST PIPE LINE CORROSION

NO-OX-ID

COATING AND WRAPPER COMBINATIONS

Write for Your Copy

of the Dearborn catalog "Preventing Corrosion of Underground Pipe Lines with NO-OX-ID and NO-OX-IDized Wrappers."

Dearborn

TRADE MARK

DEARBORN CHEMICAL COMPANY
MERCHANDISE MART PLAZA
CHICAGO 54, ILLINOIS

THE ORIGINAL RUST PREVENTIVE

NO-OX-ID

5.4 Non-Metallic Coatings and Paints

5.4.2

New Developments in Porcelain and Ceramic Coatings. P. O'KEEFE. *Materials and Methods*, **35**, No. 5, 87-89 (1952) May.

One coat enamels, improved enameling stock, and coatings having improved high temperature, abrasion and impact properties are all stimulating a wider use of porcelain enamels. The thin 1-coat enamels were made practical by titanium type frits, which have better covering power than zirconium and antimony types, can be fired directly to the iron or steel, and are acid resistant besides. The A-417 coating was developed by the National Bureau of Standards to extend part life and save scarce alloying elements in aircraft engines. Inconel heat exchangers used in the exhaust system of bombers have been coated with A-417 increasing the service life many times over. The Solar Aircraft Co. also is testing a high temperature ceramic coating.—INCO.

5.4.2, 3.5.9, 8.9.1

Ceramic Coating Saves Scarce Metals and Lengthens Life of High Temperature Parts. HUGH PENTON. California Metal Enameling Co., Inc. *Western Metals*, **10**, No. 4, 37-39 (1952) April.

With the merger of research programs of California Metal Enameling Co. and Ryan Aeronautical Co., and improved coating, A-418-Ryanco-C, was disclosed, and is used in production of aircraft engine components. Vital high temperature jet engine components, now made of Inconel, may be fabricated from Type 321 stainless steel and adapted to these same applications through the use of ceramic coatings. Article describes how parts are coated, fired and assembled. A-418-Ryanco-C is compared to A-417. Zirconium oxide, and aluminum oxide are substituted for beryllium oxide. After the coating eventually becomes ineffective, the part can be returned, the old coating stripped off, and the component can then be cleaned and recoated. Photographs are included.—INCO.

5.4.5

Coating that Protects Metals, Concrete Structures, and Wood. *Machinery* (N. Y.), **58**, No. 6, 195 (1952) Feb.

Tarlac is a fast drying protective coating made from coal-tar pitch. The pitch is broken down into minute molecules and then combined with water and a stabilizing emulsification agent to form a permanent suspension that can be brushed or sprayed on the part to be protected. It retains all the protective and adhesive qualities of coal-tar pitch and is impervious to oils, greases, other petroleum derivatives, alkalies, and acids. It will not crack or run within a temperature range of —56° to 200° F. Coating dries and forms a tough, enduring, flat back film that is completely insoluble in water, oil or gasoline. It can be thinned when necessary with water. Its uses include protective coatings for concrete structures, floors, masonry, and metals exposed to corrosive elements. Mfd. by Flash-stone Co., Inc.—INCO.

5.4.5

Hot Appllied Coal Tar Coatings. N. T. SHIDELER. *Pipe Line News*, **24**, 34-37 (1952) Apr.

Describes raw materials used, the coatings and their manufacture, and the coating process in mill and field, for pipeline pipes. Tabular data.—BTR.

5.4.5

Uses of "lac" (Indo-Chinese Natural Lacquer). SIGNORELLO. *Paint Manuf.*, **22**, No. 1, 4 (1952).

Natural lacquer is obtained from a tree grown in India, China, Indo-China, and Japan. It is collected as a latex and is stored in earthenware jars. Since it is impervious to water, oil and other solvents, it may be used to preserve surfaces prone to attack by water (e.g., ships' hulls). It is a good electrical insulator.—RPI.

5.4.5, 2.3.4, 6.3.6

Discoloration of Brass by Nitrocellulose Lacquers. E. STOCK AND E. JUNKER. *Deut. Farben-Z.*, **6**, No. 1, 14-18 (1952).

Extensive research has been carried out to trace the component of N.C. lacquers causing discoloration of the metal. Metal strips were exposed for six weeks to each raw material individually and pH was measured before and after the experiment. The results are recorded in a table. In presence of water, raw materials with pH< 7 contribute to discoloration. No definite conclusions have yet been drawn.—RPI.

5.4.5, 6.2.1

Study of Primers for Ferrous Metals in an Atmospheric Exposure. New England Paint & Varnish Production Club. *Am. Paint J., Conv. Daily*, **36**, No. 6E, 28-29 (1951).

Results are given of the condition of 56 metal primers after exposure for five years. Primers which have failed completely when exposed as single coats were blue lead in phenolic medium, red lead in a phenolic medium, white lead in raw linseed oil and a phenolic medium and an aluminum paint. Those primers which are intact include red lead and iron oxide in alkyd, phenolic and linseed oil media, red lead in linseed oil and several paints containing mica as an extender.—RPI.

5.4.5, 6.2.2

Protection of Iron by Painting. (In German.) MANFRED RAGG. *Werkstoffe U. Korrosion*, **3**, 11-17 (1952) Jan.

Discusses properties and qualities of different paints and paint ingredients as protective coatings. Data are tabulated. —BTR.

5.4.5, 8.4.3

Aluminum Paint In Marine Use. H. L. WARNECKE. *Marine News*, **38**, 32, 53+ (1952) Jan.

Aluminum paint is suited for the painting of tankers and oil storage facilities since it is neither softened nor dissolved by lubricating oils, nor discolored by high heat. It is also excellent for use in the protection of boiler fronts, engine rooms, turbine casings, pipe lines and condensers. Definite protection towards moisture and vapor transmission is due mainly to the leaf-like orientation of the pigment, forming a multiple layer of protective aluminum and binder as an effective barrier; i.e. a protection by exclusion rather than any electrolytic action. For best results a primer should be used before applying at least two coats of aluminum paint, unless the aluminum is to protect hot surfaces. A recent important development in the aluminum paint field has been the successful addition of special chromates of low hiding and tinting powder, so that as high as one pound of chromate could be added to the aluminum without any change in the metallic silver-lustre. This addition makes a true anti-corrosive out of the aluminum paint, often doing away with undercoats and primers and permitting the aluminum to become its own rust inhibitor.—ALL.

5.5 Oil and Grease Coatings

5.5.1

Rust Preventives—A General Survey. A. W. ACKERMAN. Anderson Oil Company. *Plating*, **38**, No. 10, 1047-1051 (1951) Oct.

The rust preventives described in this paper differ fundamentally from the metallic coatings and the so-called organic finishes in that they can be removed with readily procurable cheap solvents such as kerosene, naphtha, or gasoline. Because of their ease of application, general economy, and superior rust protection, they have become increasingly important and popular for rust prevention. These rust preventives form a relatively new and unique class of materials designed to protect metal from its worst scourge—rust. World War II was the accelerating influence in the development and practical application of these materials. Rust preventives properly selected and applied can do an excellent job in practically every phase of the protection of metal. They are being used successfully on machinery, motors, farm equipment, spare parts, tools of all types, dies, molds, cutters, gages, sheet steel, tubing, bar stock, wire, and on every conceivable type of material for the Armed Services and civilian industry, for parts in process, and for domestic and foreign shipment.—TDD.

5.5.1, 5.6.2, 5.4.5

To Protect Equipment That's Being "Put in Moth Balls." P. C. BARDIN. *Ind. Fin.*, **27**, No. 12, 52, 54, 56, 58 (1951).

The use of rust preventive oils, stripable coatings and sealed moisture-proof packages for the protection of machine parts and various other equipment that are to be put out of service for several months or even years, but which must be in good condition when taken into use again, is described.—RPI.

5.6 Packaging

5.6.1, 6.4.2

The Place of Aluminum in Packaging. E. G. WEST. *Metallurgia*, **41**, 204-208 (1950) Feb.

Present applications and future prospects. Types and requirements of package, packaging material, foil, collapsible tubes, cans, pressed containers, barrels and crates.—MR.

5.6.2, 1.2.4, 5.8.2

Greaseless Rifle Pack. *Ordance*, 36, Sect. I, 794 (1952) Mar.-Apr.

A new preservative pack for weapons has been standardized by Army Ordnance. It consists of an outer layer of cotton scrim, a layer of plastic-coated aluminum foil and an inner sheet of kraft paper coated with a special chemical which is a volatile compound known as VOI-volatile corrosion inhibitor. After a weapon is heat-sealed in its air- and waterproof laminated bag, its vapors permeate the pack and form an invisible

SOLVAY

T. M. REG. U. S. PAT. OFF.

SODIUM NITRITE

U. S. P.

Sodium Nitrite has long had many important uses in American industry. Many industries are now using this versatile product to do a variety of jobs. What can Solvay Sodium Nitrite do for you? For technical information on specific uses of Solvay Sodium Nitrite, write on your business letterhead to the address below.

Physical and Chemical Properties

Molecular Weight: 69.01.

Solubility in Water: 20% at −12° C., 39% at −26°C. (eutectic). 50% at 42°C., 60% at 90°C. Slightly soluble in alcohols, very soluble in anhydrous ammonia.

Negative heat of solution.

Melting Point: 271°C., decomposes at 320°C.

Appearance: Crystalline, slight yellow cast, almost 100% will pass through a No. 20 screen.

Reactions: Can be either a reducing or oxidizing agent. Provides NO_2 for azo reaction.

Quality: U.S.P. grade. Better than 99% $NaNO_2$, very low in chlorides and metallic impurities.

DO YOU HAVE A CORROSION PROBLEM?

Solvay Sodium Nitrite is an excellent anti-corrosion agent that will not injure the skin of a normal person. It will however protect a wide variety of metals including iron and steel.

Among the current applications utilizing this property of Solvay Sodium Nitrite are: prevention of corrosion in air conditioning units and circulating water systems; as a corrosion inhibitor in water base paints, water soluble hydraulic fluids, metal cutting and grinding compounds; as a rust preventive in household scouring pads and radiator anti-freeze compounds.

Do you have a corrosion problem that could be solved with Solvay Sodium Nitrite?

USES FOR SOLVAY SODIUM NITRITE

METAL INDUSTRY

- for corrosion prevention
- for detinning
- for heat treating salts
- for oxidizing compounds
- for enameling
- for specialized metal cleaning compounds

MEAT PACKING

- as a color fixative for meats

TEXTILE INDUSTRY

- in azo dyeing

ORGANIC CHEMICAL SYNTHESIS

- provides nitrite ion for diazonium reaction

SOLVAY

SOLVAY PROCESS DIVISION

ALLIED CHEMICAL & DYE CORPORATION

61 Broadway, New York 6, N. Y.

BRANCH SALES OFFICES:

Boston • Charlotte • Chicago • Cincinnati • Cleveland • Detroit • Houston
New Orleans • New York • Philadelphia • Pittsburgh • St. Louis • Syracuse

Soda Ash · Caustic Soda · Potassium Carbonate · Calcium Chloride · Chlorine · Caustic Potash Cleaning Compounds · Ammonium Bicarbonate · Sodium Bicarbonate · Snowflake® Crystals Sodium Nitrite · Para-dichlorobenzene · Ortho-dichlorobenzene · Monochlorobenzene · Ammonium Chloride

123a

film which protects every metal surface against corrosion. Even the innermost parts of the gun are protected including those inaccessible to the viscous, rust-preventive compounds.—INCO.

5.8 Inhibitors and Passivators

5.8.2, 5.4.5

Corrosion Inhibitor. *Automotive Industries,* **105,** No. 8, 88, 90 (1951) Oct. 15.

No-Rust #6, a thin film corrosion inhibitor which provides surface coverage of 390 sq. ft. per gal., is recommended for protection of metal surfaces against corrosion in indoor and outdoor exposures during domestic or overseas shipment, and for indoor and outdoor storage for long periods of time in all cases. It has no tendency to settle or separate in storage, and because of the adhesive characteristics, the coating when once applied and dried will not crack, chip, scale or disintegrate at temperatures down to 0° F, nor will it flow at temperatures as high as 190° F. The coating deposited is not over 0.008 inches thick when dipped at a temperature of 70° F and will dry sufficiently within four hours to permit handling without removal of the coating. This is applied by brushing, spraying, or dipping and is readily removed with petroleum solvents. Developed by Gulf Oil Corp.—INCO.

5.8.2, 5.5.1

Rust Preventive Compound. *Automotive Industries,* **105,** No. 5, 102 (1951) Sept.

Petrobase 210 is a synthetic rust preventive composition for petroleum oils, petrolatums and waxes. Due to its polar activity, when used in small quantities, it causes oils and waxes to displace preferentially water from metal surfaces. It prevents redeposition of aqueous vapors or liquids on the metal surface. The physical chemical mechanism controlling this displacement and repulsion of water provides protection against the most common causes of rusting. Among other characteristics, it offers humidity protection, acidic emulsion or solution displacement and salt water immersion and spray protection. Developed by the Pennsylvania Refining Company.—INCO.

5.8.2, 5.8.3, 8.4.3

Passivators and Inhibitors. M. E. Parker. *Oil Gas J.,* **50,** No. 40, 137 (1952) Feb. 11.

Modification of the environment is a basic approach to the corrosion problem. Three ways of modification are discussed. The three categories of addition of substances are direct chemical control, passivators, and inhibitors. The difference between "active" and "passive" areas on 18-8 has been measured as 0.5-0.6 volt. This difference in electro-chemical behavior makes this type of metal subject to pitting attack. Pitting of stainless steels and nickel alloys occurs in acid solutions. Inhibition may be anodic or cathodic. In corrosion of steel refinery equipment, the substances present in crude oils and decomposition products of distribution and cracking processes are organic inhibitors which lower the corrosion rate. 1 reference.—INCO.

5.8.2, 5.8.4

Silicates in Detergents. E. A. Robinson. Diamond Alkali Co. Paper before C. S. M. A., 38th Ann., Mtg., Wash., Dec. 4, 1951. *Soap & Sanitary Chem.,* **28,** No. 1, 34-36 (1952) Jan.

Silicates in detergents inhibit corrosion of aluminum. The high silicon dioxide products are best for aluminum and most light metals. The more alkaline sesquisilicate and metasilicate are best in anodic and cathodic cleaning. Silicates prevent corrosion of iron, galvanized brass and copper piping in water supplies. Polyphosphates in detergents are sequestering agents for cadmium and magnesium and they dissolve copper and zinc in brass, bronze and many monel type alloys. Blackening of white metal dairy fixtures of the Monel type by a synthetic wetting agent containing a small amount of soda is discussed. Sodium hypochlorite bleaches attack aluminum, tinned copper, nickel-silver, and cast stainless steel, and bleaches containing potassium permanganate will pit wrought 18/8. Silicates inhibit this type of corrosion.—INCO.

5.8.2, 5.8.4, 8.9.1, 7.1

VPI Joins Fight Against Rust. S. H. Reiniger. *Aviation Week,* **55,** No. 11, 48-49 (1951) Sept. 10.

Large savings in time, labor and costs, and reduction in the number of parts lost yearly in the fight against metal corrosion are predicted for VPI 260, recently placed on the market by Shell Oil Co. after extensive service tests. The product is a volatile powder that produces corrosion-inhibiting vapors. Gaining increased attention in the aviation industry, it already is used as a standard preservative throughout all three divisions of Pan American World Airways for protection of engines (inside and out) and components in storage or shipment. Other airlines that Shell says have adopted it for similar use are United, All-American, Colonial, and Capital. VPI 260 powder is a compounded synthetic organic chemical. Its active ingredient is dicyclohexylammonium nitrite. The vapors of VPI are carried by convection and diffusion to all surfaces of the part to be protected, where they condense to give a thin layer of crystals which dissolve in any water film present. The important thing with use of VPI is that the surface does not have to be coated to be protected. It counter-attacks corrosion at the source, treating the atmosphere, in effect, to render the combination of water and oxygen non-corrosive. Where some methods of protecting engines are effective in terms of weeks or a few + months, Shell claims that VPI can give protection for years.—TDD.

5.8.2, 6.2.1, 4.6.1

Sodium Benzoate and Other Metal Benzoates as Corrosion Inhibitors in Water and in Aqueous Solutions. F. Wormwell and A. D. Mercer. *J. Applied Chem.* (London), **2,** Pt. 3, 150-160 (1952) Mar.

Sodium benzoate is an effective inhibitor of the corrosion of mild steel in distilled water, in a moderately hard mains-water, and very dilute NaCl solutions. The following benzoates possess inhibitive properties: potassium, lithium, zinc, and manganese. Influences of surface finish of steel, pH, and movement, and electrode potential of steel in sodium benzoate solutions are discussed. Sodium chromate in water and in dilute sodium chlorine solutions, and other metal benzoates are compared with sodium benzoate. Sodium benzoate as inhibitor for metals other than mild steel is considered. The mild steel sheet had the following composition: 0.09 carbon, 0.019 silicon, 0.016 sulfur, 0.024 phosphorus, 0.33 manganese, 0.048 nickel, 0.038 chromium, and 0.10 copper. The disc specimens consisted of 0.13 carbon, 0.12 silicon, 0.024 sulfur, 0.04 phosphorus, 0.4 manganese, 0.23 nickel, 0.053 chromium, and 0.057 copper. Illustrations are included.—INCO.

5.8.3, 4.3.2, 6.2.3, 3.2.2

Diffusion of Hydrogen in Steel with Different Carbon Contents During Acid Pickling. S. A. Balezin and D. Ya. Solovei. Doklady Akademii Nauk SSSR, **75,** No. 6, 811-841 (1951).

Experimental study of influence of pickling inhibitors on process of hydrogen diffusion in steel. Steels studied: Plain carbon steels containing 0.14 to 1.20% carbon. Acids studied: C.P. sulphuric acid and hydrochloric acid (1-5 normal). Particulars on experimental setup for determination of rate of solution and of hydrogen diffusion in steel. Effect of carbon content of steel and of sulphuric acid concentration on rate of solution and hydrogen diffusion through steel. Influence of hydrochloric acid concentration on volume of hydrogen evolved and diffusing through steel as function of pickling time. Effect of different inhibitors, such as thiourea, thiodiglycol, acrichin, quinoline, diethylaniline, etc. on hydrogen diffusion through steel being dissolved in 5 normal sulfuric acid. Reasons for difference in effect between sulphuric acid and hydrochloric acid. Conclusions: Best way of avoiding hydrogen brittleness in steel. Contains four figures and 1900 words. $3.80. Henry Brutcher, Technical Translations, P. O. Box 157, Altadena, California.

5.9 Surface Treatment

5.9.1

Bright Dipping. R. G. Stewart. *Australasian Engineer.* 61-63 (1952) Feb. 7. (From Symposium on "The Surface Treatment of Metals.")

Describes the above process which has been applied primarily to copper and copper-base alloys and also used extensively for cadmium and zinc plating. It produces a brightening of the surface and also provides some passivation of the treated surface. The composition of the dip is determined by the composition of the material and the result desired.—BTR.

5.9.2

Cleaning and Preparing Metal Surfaces for the Application of Modern Paint Coatings. P. C. Bardin. *Ind. Finishing,* **28,** No. 1, 18-20+ (1951) Nov.

Surface cleaning with alkali, acid and emulsion cleaners, solvent and solvent-vapor treatments, thermal degreasing, steam and dry cleaning and fluid blasting processes, and phosphating of ferrous and non-ferrous metals, are described. —RPI.

5.9.2, 6.4.2

Caustic Etch Treats Aluminum Without Sludge or Scale. R. J. Stell. *Iron Age,* **169,** 138-139 (1952) Apr. 3.

Formation of sludge and scale in caustic treatment of aluminum has been virtually eliminated with a new caustic etching product. Dissolved aluminum remains in solution as sodium aluminate,

STOP RUST

Use VPI Packaging

VPI* protects ferrous metals against corrosion during transit or storage, by its *vapors*. Items to be protected are simply wrapped in VPI-coated paper.

Proper wrapping and storage will give protection up to 15 years.

VPI, made with Monsanto Dicyclohexylamine, is also available in crystal form. Crystals may be blown on metal surfaces or into machinery—packaging then seals in vapors.

With VPI there is no greasing or degreasing—no skilled labor required.

**Reg. U. S. Pat. Off. by Shell Development Co.*

For a copy of this booklet on VPI, write MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 800 North Twelfth Blvd., St. Louis 1, Missouri.

MONSANTO
CHEMICALS—PLASTICS

Serving Industry...Which Serves Mankind

VPI PROTECTS: *Aircraft engines, precision tools, auto body stampings, military weapons, tractors and heavy equipment—any ferrous metal parts, tools or instruments.*

125a

rather than being deposited as alumina on tank walls and heating coils. Tanks are easily cleaned by hosing. More consistent finishes are reported.—MR.

5.9.4

Phosphatizing Compound. *Automotive Industries,* **105,** No. 8, 90, 94 (1951) Oct.

Keykote, a phosphatizing compound for coating steel and iron at low concentrations and for short periods, is manufactured in powder form that can be used as low as 3 pH. Black iron tanks may be used and may be heated by immersion burners, steam coils, or burners under the tanks. Keykote is applied by spray or immersion and can be rinsed. Mfd. by Kelite Products.—INCO.

5.9.4, 3.8.4, 1.2.2, 1.2.3

The Protection of Metallic Surfaces by Chromium Diffusion. In Seven Parts. I. Survey of the Chromizing Process. II. Theoretical Consideration. III. Structure of Chromized Coatings. IV. Modern Chromizing Methods. V. Properties of Chromized Steel. VI. Applications of Chromizing. VII. Applications of Chromizing (Concluded). R. L. SAMUEL AND N. A. LOCKINGTON. *Metal Treatment and Drop Forging.* **18,** Nos. 71, 72, 73; 354-359, 407-415, 440-444 (1951), Aug., Sept., Oct. **18** Nos. 74, 75; 495+, 543-548 (1951) Nov., Dec. **19,** Nos. 76, 77; 27-32, 81-85 (1952) Jan., Feb.

I. An historical survey of the development of the chromizing process, covering mainly the period up to 1938. 13 references. II. An outline of the theory of the chromizing process is given. III. The microstructure of chromized coatings (mainly on steels) is described. IV. The most practicable methods at present are the D. A. L. and B. D. S. processes. Salt-bath methods may become commercially practicable for small parts. V. Covers hardness, ductility and other mechanical properties; weldability and, original data on the resistance to corrosion and oxidation in various media. VI. Discusses economics of the chromizing process; efficiency of method and equipment; shape and nature of component; and processing sequence. Typical examples are given of application of the process to impart corrosion and heat resistance to various steels. A combined chromium-silicon-aluminum diffusion treatment is described and its potenitialities evaluated. VII. Describes method which can be used to advantage for improving the wear- and abrasion-resistance of drop forging dies, hand and machine tools, and general purpose tools. Summarizes the present position and future outlook of chromium diffusion and allied processes.

5.9.4, 6.5

The Basic Types of Phosphate Coatings and Where to Use Them. R. F. AYRES. *Materials & Methods,* **34,** No. 4, 100-103 (1951) Oct.

Notes on five types of commercial phosphate coatings (phospates of manganese-iron, zinc-iron, zinc, aluminum-chromium, and iron). Short general statements on operation; table showing application of various types to iron and steel, zinc, cadmium, and aluminum, with comprehensive list of trade names of various American phosphating processes.—BNF.

6. MATERIALS OF CONSTRUCTION

6.2 Ferrous Metals and Alloys

6.2.2, 3.7.2, 3.7.4

Study of Martensite Transformation in Austenitic Cast Irons. P. LAURENT AND M. BATISSE. Paper before Reunion Mensuelle, Soc. Franc. de Met., Apr. 1951. *Rev. Met.,* **49,** 129-139 (1952) Feb.

Dilatometric study on cast irons containing: 3.0 carbon, 2.47 graphitic carbon, 1.95 silicon, 0.027 sulfur, 0.044 phosphorus, 1.0 manganese, 2.2 chromium, 20.69 nickel; 3.01 carbon, 2.30 graphitic carbon, 1.97 silicon, 0.026 sulfur, 0.045 phosphorus, 1.58 manganese, 2.51 chromium, 5.23 copper, 14.86 nickel (Ni-resist); 3.05 carbon, 2.3 graphitic carbon, 2.14 silicon, 0.046 sulfur, 0.048 phosphorus, 0.49 manganese, 16.09 nickel. Martensite formation facilitated subsequent graphitization. Austenite—martensite transformation is believed to be reversible. Increased cooling rate in austenitic region lowered Ar'''. Data on properties of the materials in various conditons are shown in tables.—INCO.

6.2.2, 7.1, 3.7.2, 2.3.7

Hardened Gray Iron—An Ideal Material for Diesel Engine Cylinder Sleeves and Liners. G. P. PHILLIPS. (International Harvester Co.) *Foundry,* **80,** No. 1 & 2, 88-95+, 107-111 (1952) Jan., Feb.

Studies to determine the most desirable type of wear-resistant iron for use in cast cylinder sleeves and liners of diesel engines are described. These studies include the causes of wear, wear tests in hardened and unhardened sleeves, and corrosion tests. Of the various types of irons, the first standard material adopted was a molybdenum-chromium-nickel alloy and as a result of the tests made, the use of this alloy was resumed for the dry type hardened liners used in truck gasoline engines. Wear tests on special irons including Ni-Resist, an alloy white iron containing 4.28-4.4 nickel, a high chromium cast iron with 0.44 nickel, Nitricast (French) with 1.06 nickel are tabulated and results showed that a variety of hardened alloy gray irons have very good wear resistance as compared to gray irons of usual hardness. Unhardened, high nickel-chromium gray iron of about 200 Brinell hardness showed good wear resistance. Properties were determined and are shown graphically. The molding and melting practices in the casting of these parts are described. Tables, graphs, and photomicrographs are given.—INCO.

6.2.5, 1.2.4

Decontrolled Stainless: A Solution to Shortages. *Steel,* **130,** No. 12, 72-74 (1952) Mar. 24.

Straight chromium grades no longer requiring CMP-4B tickets are worth investigating as a solution to many fabricating problems. Producers are looking for business. In relieving the chromium types from controls through issuance of direction 9 to CMP regulation 1, NPA defined them as stainless steel containing less than 1% nickel. This means that all of the 400 series steels can be purchased without restriction from mills or warehouses with the exception of types 414 and 431 which contain 1.25 to 2.50% nickel. Outlines the alloy content, properties, uses, forms, and prices of types 410, 416, 420, 420F, 430, 430F, 430TW, 440A, B. C, 440F, 442, and 446. Lists applications for type 430 stainless steel sheet, strip, bar, and wire. Photographs are included.—INCO.

6.2.5, 3.7.2

Efficient Utilization of Titanium Alloys in Stainless Steel Production. F. ST. VINCENT AND R. W. REBJOLZ. Vanadium Corp. of Am. Paper before Electric Furnace Steel Conf., Pittsburgh, Dec. 7, 1951. *J. Metals,* **4,** No. 3, 245-246 (1952) Mar.

Increased production of titanium-stabilized stainless steels has focused attention on the efficient utilization of ferro-titanium alloys. The ability of titanium to form stable oxides and nitrides has necessitated the adoption of modified furnace practices for obtaining reasonable recoveries. The titanium alloys available for the production of stainless steel ingots are listed. The problem of titanium recoveries was considered from the viewpoint of preventing its oxidation insofar as is possible. Another aspect of titanium recovery that warrants consideration is the sampling of the heat for titanium analysis. Tables and constitution diagrams are given.—INCO.

6.2.5, 3.7.3

Chrome Stainless: Easing the Pinch. R. E. PARET (Am. Iron & Steel Inst.) *Steel,* **130,** No. 17, 79-80 (1952) April 28.

Mechanical properties, applications and fabricability of high and low chromium steels, such as types 410, 416, 405, 403, 446, and 310 are discussed as replacements for stainless steel particularly 18-8, applications requiring nickel. No chromium stainless can compete in impact resistance with the 18-8s where extremely low temperatures are encountered. Where more corrosion resistance than that offered by Type 430 is required, and the use of nickel-bearing stainless is not justified, Type 446 can be used if precautions are taken. Welding and corrosion resistance are considered. Mechanical and physical properties and chemical compositions are tabulated.—INCO.

6.2.5, 3.7.3, 4.3.2

Corrosion of Welded 18-8 Type Chromium-Nickel Steels in Concentrated Nitric Acid. H. T. SHIRLEY AND C. G. NICHOLSON. *J. Iron Steel Inst.,* **170,** No. 2, 111-118 (1952) Feb.

Carbide stabilization by titanium less effective than by niobium and the latter should be used for resistance to concentrated nitric acid at high temperatures. Steels with 18% chromium, 8-13% nickel, and a 10/1 ratio of niobium/carbon should be free from adverse effects of welding, even in cases of double welding such as sealing welds inside vessels.—BNF.

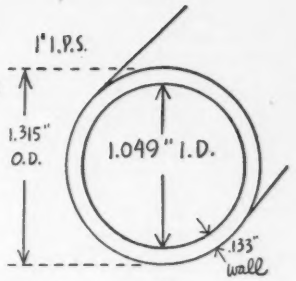
6.2.5, 4.3.7, 3.7.3

Zinc and Stainless Steel. *Aircraft Prod.,* **13,** No. 156, 316 (1951) Oct.

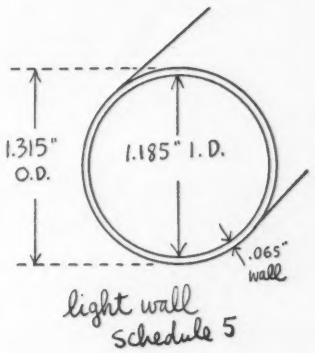
Zinc and zinc compounds, no matter how small the quantity must not come in contact with highly-stressed steel at elevated temperatures. In forming stainless steel with zinc alloy drop-hammer tools, all zinc picked up on stainless steel by contact with the tools must be removed before welding or heat-treatment. If this is omitted, the parts crack during the heating cycle. If highly-stressed stainless steel is immersed in molten

Why pay for Schedule 40 pipe where Schedule 5 is more than adequate ?

Back in the days when iron pipe was virtually the only kind available, it was necessary to specify this



But today with the high strength/weight ratio of stainless steel, the great majority of pipeline and process applications will have an ample margin of safety with this



All sizes of Carpenter Schedule 5 pipe will easily handle 150 psi working pressures. Sizes under 1½" will safely handle considerably higher pressures.

By specifying this light wall stainless pipe you gain many advantages:

1. You save money. Schedule 5 pipe costs about half as much per foot as Schedule 40.
2. Schedule 5 has the same O.D. as Schedules 10, 40 and 80—for hook-up with existing lines as well as for new installations.
3. Its larger I.D. increases flow and capacity in pipelines, exchangers and other equipment.
4. It's lighter. This means quicker and easier installation.
5. You can save 10% to 25% on valves, fittings, weld rods, etc., because smaller O.D. material can frequently be used.
6. Fittings are available from several manufacturers . . . and stocks of Schedule 5 pipe are carried by conveniently located Carpenter distributors.
7. Tubing sizes can now be replaced with light wall pipe . . . for ready hook-up with standard valves, pumps, etc.

Light wall Schedule 5 pipe saves dollars—and makes a lot of sense!

For complete data on Carpenter Schedule 5 Stainless Pipe, call your nearest Carpenter distributor or write us direct. We'll be glad to send you the information you need. THE CARPENTER STEEL COMPANY, Alloy Tube Division, Union, N. J.

Expert Dept.: The Carpenter Steel Co., Port Washington, N.Y. "CARSTEELCO"

Carpenter

THE U.S. NEEDS YOUR STEEL SCRAP NOW

more than corrosion resistance

STAINLESS TUBING & PIPE

Analysis → Tolerance → Finish →

- guaranteed on every shipment

127a

zinc, the rate of solution along the grain boundaries on the area in tension is much higher than in unstressed steel. Solution of metal along the grain boundaries might completely penetrate a piece of steel 0.050 inches thick in less than 1 second at 1400° F. The detrimental effect of zinc is apparent even at temperatures as low as 800° F. Cracks can be caused if zinc alloy is allowed to remain on stainless steel during welding or annealing.—INCO.

6.2.5, 5.3.4, 6.2.3

Stainless Clad Steels. H. THIELSCH. Welding Res. Council. *Welding J.*, **31**, No. 3, 142s-160s (1952) Mar.

Manufacturing methods including roll welding, casting, intermelting, arc and gas welding, and the Colclad Process, carbon diffusion, physical and mechanical properties, heat treatments, welding procedures and processes, dilution, selection of welding electrodes, flame cutting and joining of stainless clad steels of various types are discussed. Nickel plating is used in roll welding and casting. Differentiation between stainless clad steels and applied liners is given. The presence of a narrow nickel-plated layer between stainless steel cladding and backing steel reduces carbon diffusion. Tables, illustrations, 81 references.—INCO.

6.3 Non-ferrous Metals and Alloys—Heavy

6.3.1, 3.4.6, 3.7.1

"Perpetual Interest" of Non-Ferrous Research. G. L. BAILEY. *Foundry Trade J.*, **92**, No. 1854A (Golden Jubilee Number), 39-43 (1952) Mar. 15.

Extent of the scientific knowledge which has been gained of the foundryman's art over the past 50 years. Comments are made on the solidification of alloys, low-shrinkage alloys, grain refinements, gases in metals, in particular in copper, nickel, and aluminum, oxidation treatments and effects of gas absorption. 30 references.—INCO.

6.3.6, 2.1.2, 3.5.1

Alloys with High Conductivity. W. W. KEE. *Rev. met.*, **49**, 89-98 (1952) Feb.

Deals with high-conductivity copper-base alloys, classified according to response or lack of response to heat-treatment. Data on structure, mechanical, physical and electrical properties of copper, copper-tellurium, copper-silver, copper-cadmium, copper-chromium, copper-chromium-silicon, and copper-nickel-phosphorus alloys are given.—INCO.

6.3.6, 3.7.2, 3.7.3, 7.10

Beryllium Copper Wire: Part I—Its Processing and Uses; Part II—Property and Design Considerations. J. T. RICHARDS. Beryllium Corp. *Wire and Wire Products*, **27**, Nos. 2 & 3, 149-154+, 257-363+ (1952) Feb., Mar.

Part I discusses beryllium-copper wire including forming, heat-treating, plating, joining and applications. Commercial beryllium-copper wire, nominally 1.9 beryllium contains 0.2 nickel or cobalt, 0.6 nickel plus cobalt plus iron, 99.5 copper plus beryllium plus additions. Although beryllium-copper was originally finished as a binary alloy, commercial materials now contain small quantities of cobalt or nickel to inhibit grain growth and provide more uniform hardening response. Minor impurities include iron, silicon, aluminum, tin, and zinc. The addition of small quantities of cobalt or nickel into the binary copper-beryllium-system slightly reduces the solubility of beryllium. Beryllium-copper can be plated for appearance, added protection, die lubrication and electrical properties with chlorine, zinc, tin, copper, chromium, nickel, silver, rhodium, and gold.

Part II discusses the physical and mechanical properties, effect of cold work and fabrication, heat treatment, temperature, fatigue, anelastic properties, elastic modulus corrosion resistance and design considerations. Illustrations, 33 references.—INCO.

6.3.6, 7.1

A Reliable Leaded Bronze. HAROLD J. ROAST. *Foundry*, **80**, 117, 200-202 (1952) Feb.

Tells how long and successful experience with the alloy ASTM B30-49 (3D) +3% zinc recommend it for bearings and castings required to resist corrosion and internal pressure. Melting practice is discussed.—BLR.

6.3.10

Nickel-Base Nonferrous Castings. J. S. VANICK. Inco, *Foundry*, **80**, No. 4, 94-97+ (1952) Apr.

Production, engineering properties and applications of Monel are discussed. Chromium-silicon-molybdenum varieties of Monel have been experimentally developed and show considerable promise. Nominal composition and properties of Monel, nickel and Inconel castings as well as for Colmonoy, Durco, Chlorimet,

News Deadline for CORROSION

10th of Month Preceding Month of Publication

NACE Secretaries may obtain on request copies of "NEWS REPORT to CORROSION"

●

Notices of meetings to be run in advance should be sent in two months before the meeting date. These notices may include as much information as is available at the time including the date, time, place, name of speakers and topics to be discussed. Tentative programs are suitable for publication. Names and addresses of persons to receive registration and fees in advance should be given.

●

Reports on meetings prepared after the meeting may include all the events, with names and company affiliations of speakers, together with titles and a summary of the speakers' comments. Photographs taken during meetings are welcomed and will be run when they arrive in time for use. Where officers have been elected or changed the specific time at which they assume office should be given.

●

CORROSION is anxious to cooperate with associations and organizations other than NACE in carrying notices in advance of meetings and reports of meetings when these meetings include events interesting to NACE. The same deadlines as those applying to NACE communications apply to notices from other organizations.

●

The NACE always welcomes receipt of comments or discussions of its technical material. Persons who wish to discuss constructively technical material in CORROSION are invited to submit three copies to: Central Office, National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Texas.

Hastelloy, Illium, Langalloy and Waukesha are given in table form. Graphs and illustrations are included.—INCO.

6.3.13, 4.4.1, 4.3.2

The Corrosion Forum—Tantalum. A. L. PERCY. Fansteel Metallurgical Corp. *Chem. Eng.*, **59**, No. 4, 259-260, 262-264 (1952) April.

Chart data presentations giving corrosion data for tantalum vs. a number of corrosives such as acids, acidic salts and organic reagents.—INCO.

6.3.18, 3.7.3, 3.5.9

Vanadium-Base Alloys. WILLIAM WILSON, JR. *J. Metals*, **4**, No. 2, 144 (1952).

An A.I.M.M.E. Research in Progress summary. Massive vanadium appears to show the existence of a second phase. On heating in air below 600° C. a protective scale forms on the surface of the metal, while above 700° C. a molten scale is formed; the two processes are undoubtedly delineated by the melting point of vanadium pentoxide viz. 658° C. Arc-melted vanadium can be: 1) hot rolled below 900° C. when it is sheathed in stainless steel, and 2) held at 1050° C. for several hours without a material increase in hardness if calcium is put into the sheath as a getter. The physical and oxidation-resistance properties of vanadium-base alloys with cobalt, chromium, iron, manganese, nickel, tantalum, titanium, nitrogen, and oxygen are being studied; those with nickel, tantalum, and titanium appear the most promising. Most alloys require rolling temperature above 900° C., and even then work-harden greatly; any brittleness encountered is probably the result of contamination.—MA.

6.3.19, 3.7.2, 3.2.2

Recent Work on Pressure Cast Zinc Alloys. (In German.) K. LOHBERG. *Metall.*, **5**, 282-288 (1951) July.

Above shows that lead, tin, or cadmium impurities decrease resistance of zinc alloys to hydrogen corrosion, and that salts are ineffective in removing impurities. Superheating likewise increases oxidation and iron content of pressure castings, but up to 6.6% copper has no effect on aging resistance of alloys. Physical properties are also discussed. Photographs, photomicrographs, tables, and graphs are included. 16 references.—BLR.

6.3.20, 3.8.4

The Permeability of Zirconium to Hydrogen. RICHARD B. BERNSTEIN AND DANIEL CUBICCIOTTI. *J. Phys. and Colloid Chem.*, **55**, No. 2, 238-248 (1951).

The authors have measured the permeability of zirconium to hydrogen, using a hydrogen purification train, a stainless-steel holder for the zirconium sheet disc, and a vacuum-type collection burette. Purified hydrogen was passed through a liquid nitrogen trap and up to the zirconium disc which was sealed between two flanged tubes, surrounded by nitrogen, in a furnace maintained at temperatures up to 920° C. The diffusing hydrogen was collected and measured in the evacuated system downstream of the zirconium disc. The flow rate at constant temperature and pressure was found to decrease with time and to be sensitive to the surface condition of the specimen. Values of the flow (E) at different temperature were corrected to the same time and $\log_{10}$ flow rates, for this time, were plotted against 1/T. The lowest values for E appeared to be 65 and 85 kg. cal./mole, respectively for two sets of experi-

ARco Rubber Lining on your Chemical Equipment will Increase Protection and Reduce Down-time!

● ARco offers every rubber lining and covering facility in completely equipped plants at Detroit and Houston. If your chemical equipment cannot be moved and processed, ARco Field Service Units will come to you anywhere in the country. They will bring their skill and the best protective materials known to your locality.

Each ARco Field Service Unit is staffed with experienced craftsmen and supervisors. Their thorough knowledge of this specialized work is your assurance of complete satisfaction.

Let ARco Engineers advise you on your corrosion problems. Field estimates made on request.

SEND FOR THIS INFORMATION TODAY! Literature showing ARco rubber applications to equipment, parts and installations in every industrial field.

ANYTHING CAN BE COVERED WITH RUBBER — BY ARco

ARco RUBBER PROCESSORS

DIVISION OF AUTOMOTIVE RUBBER CO., INC.

4033 Homestead Road • Houston, Texas

LICENSED APPLICATORS OF AMERCOAT PROTECTIVE COATINGS

MANUFACTURERS • DESIGNERS • ENGINEERS

129a

ments. It was shown that, at a selected reference time, the flow rate varied with the sq. root of the pressure. The effect of sample thickness could not be evaluated because of the variation in flow rate observed between samples of similar thickness. The authors suggest that the time dependence of the flow rate is due partly to a change of structure in the zirconium caused by the solution of hydrogen and partly to the formation of an oxide film. 12 references.—MA.

6.4 Non-Ferrous Metals and Alloys—Light

6.4.2

Aluminum Needs Good Connections. JULIAN ROGOFF AND IRVING MATTHYSSE. *Electric Light and Power*, **30**, 118-122 (1952) Feb.

Describes a test program conducted in an effort to overcome the following characteristics of aluminum antagonistic to good electrical points: oxide coatings, poor electrical conductivity, electrolytic corrosion, and softness which causes excessive creep.—BLR.

6.4.2, 2.2.2, 2.2.7

Studies on the corrosion of Aluminum Alloy Castings. M. SUGIYAMA, N. TAKAHASHI. *Light Metals* (Japan), No. 3, 58-65 (1952) May.

Corrosion tests of various aluminum alloy casting specimen were carried out in atmosphere, tap water and sea water. Results obtained were as follows: 1) The corrosion resistance of virgin aluminum was superior to that of secondary aluminum. The decrease in tensile strength of the secondary aluminum castings caused by corrosion in tap water during two years was about 45-65%. 2) On the aluminum-magnesium alloy castings, the reduction percentage of the tensile strength caused by one year corrosion was 10-15% in the case of tap water. 3) The corrosion products produced on the surface of the aluminum-magnesium alloy castings in sea water, contained calcium oxide and magnesium oxide.—JSPS.

6.4.2, 3.4.3

From a Metallurgist's Notebook: Stained Aluminum Kettles. H. H. SYMONDS. *Metal Industry*, **80**, 5-6 (1952) Jan. 4.

Results of an investigation to determine the cause and remedy of brown stains on aluminum kettles shipped to Australia and India. Cause was found to be certain conditions of temperature and humidity and not the wrapping.—MR.

6.4.2, 3.7.1

Properties and Applications of Super-Purity Aluminum. *Alluminio* (Italy), **20**, No. 4, 329-339 (1951).

The aluminum industry in Italy after the second world war is reviewed. The three processes for the refining of aluminum are described, namely the three-layer method, the mercury cathode cell method, and the subhalide method. The physical and mechanical properties of super-purity aluminum are discussed and some applications listed: a) in the chemical industry, b) for protection of underground electric cable, c) in astronomy equipment as a substitute for silver, due to its highly reflective properties, d) in electric condensers, e) for ornamental purposes. It is pointed out that cladding ferrous metals with super-purity aluminum renders them much less susceptible to corrosion. Special alloys of pure aluminum are particularly suitable in applications requiring a) electrolytic polishing, b) high resistivity to corrosion, especially for under water purposes, and c) exposure to high temperatures. The heat resistivity of alloys of the RR58 type with relation to the silicon content is studied and compared to commercial and super-purity aluminum. Diagrams and graphs illustrate applications and properties. A bibliography of thirty references is appended.—ALL.

6.4.2, 3.7.2

A Review of Information on the Effect of Impurities on the Corrosion Resistance of Aluminum. M. E. WHITAKER. *Metal Industry* (England), **80**, 183-186, 207-212, 227-230, 247-251, 263-266, 288-289, 303-305, 313, 331-332, 346-350, 387-388 (1952) March 7-May 9 (inclusive). (Prepared for the B.N.F.M.R.A.)

This is a survey based on some 180 references, which covers general considerations, aluminum and the five main groups of wrought alloys, and casting alloys. The author has covered the general considerations in a corrosion study, corrosion means most widely encountered—atmospheric, water corrosion, and corrosion by acids and alkalis. In parts 3 to 7 of the series a detailed report is given, with an extensive bibliography of the effect of impurities on the wrought alloys aluminum-magnesium, aluminum-copper-magnesium, aluminum-manganese, aluminum-magnesium-silicon, aluminum-zinc-magnesium and aluminum-zinc-magnesium-copper. The last three articles deal with the resistance of the cast aluminum-copper-silicon, aluminum-silicon and aluminum-zinc-magnesium alloys. The full review was made available to B.N.F.M.R.A. members as R.R.A. 916 in May 1951. Reprints will be available as R.R.A. 916P. It has been brought up to date by inclusion of information published up to the end of 1951. It is of interest that the information for this review was sorted out from the available literature by manual selection of edge-punched cards.

6.4.2, 4.2.5, 4.6.11, 5.9.4

Anti-corrosion Aluminum Alloy Castings for Marine Use. H. MOTOYASHIKI: *Kobe Seiko*, **1**, No. 4, 44-52 (1952) Jan.

In this paper, the writer stated the characteristics of anti-corrosion aluminum castings for marine use and their utilization in Japan.

In foreign countries, aluminum had already been used in large quantities before World War II, but it had been little used in Japan. After the war, in order to develop its utilization, the Committee of Light Metals for Ship Building Industry consisting of experts of all the fields concerned was established in August, 1949, and research and tests have been carried out, producing good results step by step. The writer, as member of the aforesaid Committee, has been engaged in the research and trial production of anti-corrosive aluminum alloy castings. Outline of results to date described as follows:

1) Japanese Industrial Standard of Aluminum Casting Alloys for Marine Use. Three kinds of alloys—5 percent Magnesium Hydronalium (No. 1), 10 percent Magnesium Hydronalium (No. 2) and Silumin (No. 3) have been determined upon, modeling after the standard of the ALCODA of U.S.A. and ALCAN of Canada.

2. Corrosion Resistance to Sea Water. As a result of corrosion test conducted in the laboratory, it has been proved that Hydronalium is superior to mild steel and bronze in point of corrosion resistance to sea water. When fitted to a ship, side scuttles tentatively made of Hydronalium stood against a long voyage.

3) Preventive Measures against Contact Corrosion. By direct contact with mild steel or brass, aluminum alloy is corroded severely. We studied isolation methods by inserting some material between the two metals, and found that zinc plate was the best.

4) Coating. As a result of our experiments on sixteen methods in coating, which were formed by combining four kinds of coating materials with four kinds of preliminary treatment, two processes—anodizing-melamine process and phosphoric acid-alcohol melamine treatment process—proved to be superior to the others.—JSPS.

6.4.2, 4.4.7

Aluminum Die Castings Give Good Service in the Presence of Soap and Detergents. Precision Metal Molding, **10**, No. 3, 38, 81-83 (1952) Mar.

The Thor Corp. uses aluminum die castings in washing machine parts because they are economical and resistant to corrosion by soap and detergents. Reasons for the use of die casting are given. Illustrations.—INCO.

6.4.2, 4.4.10

Corrosion of Aluminum by Phenol. W. W. BINGER and R. H. BROWN. *Chem. Eng.*, **58**, No. 8, 224 (1951) Aug.

Aluminum alloys are highly resistant to phenol, making it possible to ship solid phenol in aluminum drums. Maximum temperature for use in handling phenols contained in aluminum alloys is 356° F (180° C), providing about 0.3 percent water is present. Temperature of dry phenol should not exceed 248° F (120° C). Calculated rate of attack by phenol on aluminum is about 0.001 ipy. No discoloration of the products results. In laboratory tests, 2S alloy was almost unaffected after one month at room temperature in phenol solutions containing from ½ to 90 percent by weight of phenol purified by distillation. No pitting was observed.—ALL.

6.4.2, 8.9.5

Corrosion of Light Metals for Ship Construction. CHOJIRO AIDA and SHOJI ONISHI. *Light Metals* (Japan) No. 1, 79-86 (1951) Nov.

We found by one year's examination that the pure aluminum plate and some hydronarium plates are excellent in weathering test and alternating immersion test. Decrease in tensile strength of each material was not observed for almost one year, but decrease in elongation was noticed slightly. Corrosion loss was 1/230 (in alternating immersion test) and 1/125 (in weathering test) of that of mild steel.

Though Alumite coating was excellent as compared with 2S, we found that they had the same tensile strength.

2S, 52S, and 56S even without any treatment get better results than Alumite coating treatment. Phthalic resin paint was the best among paints. The first six months it produced a bad result (blistering) and the next six months—

chalking. A common red lead paint was not so bad as we feared from appearance, but under the paint film or on bared material we observed local corrosion and, therefore,—decrease in mechanical properties.—JSPS.

6.4.2, 5.1, 3.1

Corrosion of Aluminum. G. W. ORTON. USAF. *Technical Data Digest,* **17,** No. 3, 16-23 (1952) Mar.

A discussion on the engineering principles involved in the corrosion of aluminum considers chemical attack, electrochemical mechanism of corrosion, metallographic considerations, influence of hydrogen, stress corrosion, copper-bearing alloys, aluminum-magnesium alloys, aluminum-magnesium-zinc, inhibitors and passivators, cathodic protection, surface treatments, paint protection and electroplating. Metals that are cathodic to aluminum, such as copper, nickel and chromium may cause electrolytic corrosion through breaks and pores in the coating but zinc and cadmium are satisfactory. Electroplated coatings are applied to improve wear resistance, change the appearance of the surface, reduce electrical resistance of contacts or facilitate soldering. Methods for preventing corrosion are presented. Illustrations, 36 references.—INCO.

6.4.4, 4.2.5, 4.6.11, 2.2.1

Corrosion of Magnesium Alloy ZK60A in Marine Atmosphere and Tidewater. F. M. REINHART. (Nat'l. Bureau of Standards) National Advisory Committee for Aeronautics, Technical Note No. 2632, Feb. 1952, 10 pp.

The corrosion resistance of unprotected magnesium-zinc-zirconium alloy ZK60A was determined in a marine atmosphere and in tidewater. The unprotected alloy was so rapidly attacked in tidewater that it would be of no practical value in applications subject to wetting by sea water. In the marine atmosphere, the rate of corrosion was much less and the alloy should give good service if adequately protected by good surface treatment and a good paint system. Photographs and tables.—INCO.

6.6 Non-Metallic Materials

6.6.5, 3.5.9

Silicate Cements. R. B. SEYMOUR and R. H. STEINER. Atlas Minerals Co. *Chem. Eng.,* **59,** No. 3, 268 (1952) Mar.

The corrosion resistance of silica-filled chemically-setting silicate cements will withstand higher temperatures than furane, phenolic, and sulfur cements. Silicate cements are prepared by adding approximately two parts by weight of powder to one part by weight of silicate of soda liquid in order to form a trowelable mortar. Physical properties of silicate cements are given. Photographs are included.—INCO.

6.6.5, 4.3.1, 4.4.1

Phenolic Cements. R. B. SEYMOUR and R. H. STEINER. Atlas Mineral Prods. Co. *Chem. Eng.,* **59,** No. 1, 264+ (1952) Jan.

Chart presentations giving corrosion data for phenol formaldehyde resin cements with pure carbon filler vs. a number of corrosives such as acids, both organic and inorganic, alkalis, salts and organic compounds.—INCO.

6.6.5, 4.3.2

Sulfur Cements. R. B. SEYMOUR and R. H. STEINER. Atlas Minerals Co. *Chem. Eng.,* **59,** No. 2, 288+ (1952) Feb.

Sulfur cements available commercially as mixtures of fillers with sulfur and as homogenous plasticized-filled sulfur ingots possessing low coefficients of expansion are used for joining cast iron pipe. They are resistant to non-oxidizing acids and salts but should not be used in the presence of alkalis, oils, grease, or solvents and above temperatures of 200° F. Plasticized sulfur cements protected by brick, joined by chemically resistant resin cement is used for high temperature pickling of steel with sulfuric acid, while carbon brick joined with carbon-filled sulfur cement is used for pickling of aluminum or stainless steel with nitric or hydrofluoric acid. An underlay of an impervious membrane like synthetic rubber or plastic is used beneath brickwork joined with sulfur cements in steel structures. Properties of sulfur and plasticized sulfur cement and charts for corrosion resistance of plasticized silica-filled sulfur cements are given.—INCO.

6.6.6, 6.2.3, 3.4.3, 8.10.2

Mineralogical Study of the Corrosion of Checker-Brick from Open-Hearth Steel Furnaces. LIANG-HO SU. *Trans. Brit. Ceramic Soc.,* **49,** No. 10, 420-453 (1950) *J. Am. Ceramic Soc.,* **35,** No. 4, 63 (1952) Apr.

Corroded silica brick from the regenerator chambers of two open-hearth furnaces were studied. The phases present in the corrosion products are identified by microscopic and X-ray methods (tridymite, wollastonite, spinel, pyroxene, quartz, anhydrite, andradite, pseudowollastonite, etc.). Six complete quantitative chemical analyses were carried out. The development of the corrosion process is discussed. Comparisons of mineral assemblages found in the corroded brick with those occurring in nature were made. 78 references.—INCO.

6.6.8, 3.5.3

Morphological Aspects of Abrasion and Wear. G. SALOMON. *Engineering,* **173,** 310-312 (1952) Mar. 7.

Wear phenomena of some organic materials of construction is considered against the well-known background of metal science. Recent work in this field, together with some relevant observations on polymer films, is surveyed.—BTR.

6.6.11, 4.6.4, 3.3.4, 4.3.3

Deterioration of Wood in Cooling Towers. A. H. BAECHLER and C. A. RICHARDS, Madison, Wisconsin. *Trans. ASME,* **73,** No. 8, 155 (1951) Nov.

The premature deterioration of wood in cooling towers has received considerable attention during the past several years. The authors describe the significant properties of redwood lumber used in cooling tower construction and conditions prevailing in a cooling tower that are conducive to wood deterioration. Laboratory tests indicate that pieces of salts removed from cooling towers after six to eight years of service, and exposed to fungi in laboratory tests, show much greater loss in decay than pieces of unused redwood. Thin cross sections exposed to solutions of sodium carbonate and sodium hypochlorite were less resistant to decay than those exposed to water.—NALCO.

6.6.11, 4.6.4, 3.3.4, 4.3.3

Wood Deterioration in Cooling Towers. D. R. BAKER. The Marley Company, Inc. *Petroleum Engr.,* **23,** No. 4, C-76 (1951) Apr.

Wood deterioration is caused by both chemical and biological attack. Delignification is generally attributed to the presence of sodium carbonate in the cooling water. Minute quantities of other pulping agents are often present that may account for the different types of delignification.

Highly colored woods are normally most durable. This condition is attributed to toxic qualities of extractives in the wood structure that act as fungicides and protect the structure from biological attack.

Details of the attacking forces and methods of combatting deterioration are included.—NALCO.

6.7 Duplex Materials

6.7.2, 3.5.1

The Development of Cemented Carbides in Germany. E. AMMANN and J. HINNUBER. *Stahl und Eisen,* **71,** No. 21, 1081-1090 (1951) Oct. 11.

The history of sintered carbide development in Germany starts with the production of sintered, carbon-unsaturated tungsten carbide. The use of cobalt as binding agent for the tungsten carbide particles led to tungsten carbide-cobalt alloys, having cobalt contents ranging from 6 to 30%. Studies of structural processes resulted in new alloys having essentially the same composition as earlier types, but with improved mechanical properties and durability. Significant progress resulted from the admixture of titanium carbide and tantalum carbide. Alloys containing

PLASTIC COATINGS

Vinyl and phenolic coatings, flame sprayed polyethylene and special cement linings, for protection against corrosion and or contamination. Applications made in our plant or in the field to processing, storage and transportation equipment for oil, food, water, chemical and allied industries.

Other Metalweld services include Rubber and Koroseal lining, Metallizing, Sand Blasting and Welding. Inquiries are invited. Write for Bulletin (A).

MW

PROTECTIVE COATINGS DIVISION
METALWELD, INC.
SCOTTS LANE & ABBOTTSFORD AVENUE
PHILADELPHIA 29, PA.

Write for Rates, 1061 M & M Bldg. Houston 2, Texas

CORROSION DIRECTORY

Over 5400 Paid Readers Monthly

Cathodic Protection

ALL-CO
CATHODIC PROTECTION
Design • Installation • Surveys
Equipment • Supplies
ALLEN CATHODIC PROTECTION CO.
P. O. Box 386 Phone EDison 2081
HARVEY, LOUISIANA

Cathodic Protection Service
Engineering - Installation - Surveys
Material – Supplies
Everything in the Cathodic Protection Field from an Insulating Washer to a Turnkey Contract Installation
4601 Stanford – HOUSTON – Phone JA 5171
NEW ORLEANS 1639 Robert St. Phone CH-8310
TULSA 310 Thompson Bldg. Phone 2-9857

CORROSION RECTIFYING CO.
1506 ZORA ST. VA 7522 HOUSTON
CATHODIC PROTECTION
SURVEYS – DESIGN – INSTALLATION
• Pipe Lines • Offshore Platforms
• Refinery & Gasoline Plant Lines
• Municipal Systems • Barges

CORROSION SERVICE LIMITED
Offers in CANADA
A Complete Service in Corrosion Engineering, Design and Installation of Cathodic Protection Systems.
Resistivity and Electrolysis Surveys.
Selection and Application of Protective Coatings.
Rectifiers — Anodes — Materials
21 King St. East, Toronto, Canada

CATHODIC PROTECTION
Surveys Engineering
Installation Maintenance
Electro Rust-Proofing Corp. (N. J.)
BELLEVILLE 9, NEW JERSEY
Atlanta – Chicago – Dallas – Monrovia

• *Complete*
CATHODIC PROTECTION
Systems . . . supplies . . . service for special applications; water tanks and pipe lines.
HARCO CORPORATION
16901 Broadway Cleveland, Ohio

Cathodic Protective Systems Designed and Installed
Coating and Laying Specifications; Corrosion Surveys; Consultation On All Types of External Pipe Line Corrosion.
Huddleston Engineering Co.
Bartlesville Oklahoma

Cathodic Protection

Pipeline Maintenance
Again in 1952, we lead all contractors in Magnesium Anodes installed
LET US SHOW YOU WHY
CATHODIC PROTECTION INSTALLATION ENGINEERING – SURVEYS
(Complete job or installation only)
PIPELINE Maintenance CORPORATION
3-8126 TULSA, OKLAHOMA BOX 1424

Dependable Selenium Rectifiers for Cathodic Protection
are manufactured by
Richardson-Allen Corporation
a manufacturing affiliate of
WESLEY BLOCK AND COMPANY
39-15 MAIN STREET, FLUSHING, NEW YORK
IN CANADA: Richardson-Allen of Canada, Ltd., 370 Victoria St., Toronto, Ontario

RIO *Engineering Co.* CATHODIC PROTECTION
your shield against corrosion
PROVEN EXPERIENCE
in Installation, Field Survey, Design
• RECTIFIER SYSTEMS • GALVANIC ANODES
YOU CAN RELY ON RIO
1434 W. ALABAMA HOUSTON • KEystone 9792

CATHODIC PROTECTION
Distributors and Contractors
• T. D. Williamson Casing Insulation • Good-All Rectifiers • Dow Magnesium Anodes • National Graphite Anodes • Instruments and Insulation • Contract Anode Installations.
STUART STEEL PROTECTION CORP.
Kenilworth New Jersey

Coatings and Linings

CORROSION ENGINEERING
and application of chemical resistant linings and coatings
Exhaust Systems
Storage, Plating and Pickling Tanks
Tank Trailers
Pipe—Degreasers
Filter Presses
A & P FINISHING & MFG. CO.
17760 Clarann Avenue
MELVINDALE (Detroit) MICH.

CORROSION-PROOF LININGS CEMENTS BRICK
• TANKS, FLOORS, FUME DUCTS AND PROCESS EQUIPMENT
• COMPLETE LINE OF PROTECTIVE COATINGS . .
Over a Quarter Century of Experience
CEILCOTE CORROSION-PROOF MATERIALS • CONSTRUCTION • SUPERVISION
The CEILCOTE Co. 4832 RIDGE RD. CLEVELAND 9, OHIO

Coatings and Linings

HARTMAN – HANKS – WALSH PAINTING COMPANY
5078 Easton Ave. St. Louis 13, Mo.
Cable APCO—Phone FOrest 6222
SPECIAL COATINGS APPLICATORS
Sandblasting Painting
• Perma-Skin Anti-Corrosion Vinyl Coatings
• Spring-Kote Corrosion Resistant Mastics
• Dum-Dum Masonoc – A Complete Spray Painting Service

Engineering Service

DEUBER LABORATORIES
Bacterial Corrosion Fungus Resistance Tests
Soil Performance Tests of Coatings, Tapes, etc.
Industrial Research
114 East 32nd Street New York 16, N. Y.
Telephone: LExington 2-3244

CORROSION ENGINEERING
SURVEYS • DESIGNS • SPECIFICATIONS
Impartial Evaluation
THE HINCHMAN CORPORATION
Engineers
Francis Palms Bldg., Detroit 1, Mich.

A. V. SMITH ENGINEERING CO.
CONSULTING ENGINEERS ON CORROSION PROBLEMS
Coulter Bldg. Ardmore, Pa.
Midway 2-9999

Instruments

INSTRUMENTS
For the Corrosion Engineer
• Copper Sulfate Electrodes
• Resistivity Rod & Pipe Prod
• AC Bridges
• No Current Potentiometer with Current Ranges
J. L. COLLINS
ANGLETON, TEXAS

Pipe Coating and Wrapping

SERVING ALL PIPELINES
PIPELINE ASBESTOS FELT
Made by The Ruberoid Co.
COAL TAR ENAMEL COATINGS
Made by Pittsburgh Coke & Chem. Co.
FIELDJOINTERS
Made by American Coating Supply Co.
"Steve" Day
S. D. DAY COMPANY
1973 W. Gray Houston 19, Tex.
Phone JU-2431

Advertising in this Directory costs about $1.25 a thousand circulation in 46 states and 40 foreign countries

POSITIONS WANTED and AVAILABLE

- Active and Junior NACE members may run without charge two consecutive advertisements annually under this heading, not over 35 words set in 8 point text type.
- Firms seeking employees, regardless of NACE membership, may run an advertisement of the same specifications indefinitely.
- Advertisements to other specifications will be charged for at standard rates.

Positions Wanted

Sales Engineer: Married, family, 34. Solid chemical background in research, production, technical service. Recently 5 years direct and distribution sales, chemical equipment, coatings, linings, North East territory. Management experience. Prefer equipment or resins sales. CORROSION, Box 53-9.

Positions Wanted

Corrosion Engineer: BS Metallurgical Engineering, 7 years hydro-metallurgical research, 5 years plant inspector and corrosion engineer as well as plant metallurgist in high pressure, high temperature installation. Prefer Rocky Mountain area or West. CORROSION, Box 53-8.

•

Corrosion Engineer: Four years experience with major company in corrosion control of bare and coated pipelines. BS degree in electrical engineering. CORROSION, Box 53-10.

•

Requests for additional copies of CORROSION should be addressed to Central Office. NACE, 1061 M & M Bldg., Houston 2, Texas. Single copies are sold to members at 50c each and to nonmembers at $1 each. A list of exhausted issues is published frequently during the year in CORROSION.

Positions Available

Corrosion Engineers. Positions available for graduate electrical engineers or equal. Previous field and design experience in corrosion mitigation systems required. Extensive travel involved. Salary open. The Hinchman Corp., Engineers, Francis Palms Bldg., Detroit 1, Mich.

•

Sales Representatives for DEL Protective Coatings. Protected territories available to qualified individuals of companies. No objection to carrying noncompetitive lines. Write David E. Long Corp., 220 East 42nd St., New York 17, N. Y.

•

Corrosion Engineer—For laboratory work on corrosion problems of research and development nature. Infrequent travel. Chemical, electrical or metallurgical background preferred. $4-$6000 per annum, N. Central Jersey location. Reply CORROSION, Box 53-11.

HALF-YEAR MEMBERSHIPS IN NACE

New members joining the National Association of Corrosion Engineers after July 1 have the option of taking a membership for half the calendar year, July-December inclusive at $5.

- This half-year membership entitles the member to receive copies of CORROSION magazine for the months of July-December, inclusive and all the benefits of the association after July 1.
- If you are interested in membership in NACE write for an application for membership or see the NACE Section secretary if an NACE section operates in your city.
- Applications for membership for the whole of the calendar year will be accepted also and copies of CORROSION supplied for the whole year as long as the supply of back issues lasts.

Write to A. B. Campbell, Executive Secretary NATIONAL ASSOCIATION OF CORROSION ENGINEERS, 1061 M & M Bldg., Houston 2, Texas.

NACE POLICY ON DUES IN ARREARS

No member of the association with dues in arrears for three months shall receive publications of the association until such dues are paid. Members in arrears one year shall be dropped automatically from membership.

If your dues are not received at Central Office by the latter part of March, you will be dropped from the list to receive NACE publications and mail. Accordingly the March issue of CORROSION will be the last received by those so dropped.

In order to avoid interrupted mail and missed copies of CORROSION members are urged to remit dues before the deadline. Much work will be eliminated at Central Office if members remit before the date stipulated.

HERE'S NEW OPPORTUNITY FOR A CORROSION RESEARCH MAN

Have you at least 5 years of industrial or institutional experience in the development and formulation of rust preventives, protective coatings, petro chemicals, wax and oil type hydrocarbons, corrosion inhibitors, etc.?

Also the successful applicant will have a creative approach to research plus the ability to stimulate co-workers.

Starting salary is open...the opportunity for growth what you make it. Write or phone Mr. W. H. Bingham. Expense paid interview if not nearby.

Dearborn TRADE MARK

DEARBORN CHEMICAL COMPANY
Merchandise Mart Plaza, Chicago 54, Ill.
Phone: Whitehall 4-3273

Write for Rates, 1061 M & M Bldg. Houston 2, Texas **CORROSION DIRECTORY** Over 5400 Paid Readers Monthly

Pipe Coating and Wrapping

YOUR ADVERTISING in this space goes to over 5400 readers monthly

Testing

South Florida Test Service
INSPECTION – TESTING – RESEARCH ENGINEERS
(Established 1931)
Corrosion, weathering and sunlight tests. Four locations in Southern Florida for inland, salt atmospheric, tidewater and total immersion exposure tests.
4201 N. W. 7th St. MIAMI, FLORIDA

Water and Steam

WATER SERVICE LABORATORIES, INC.
Specializing Since 1927
Water treatment for corrosion control in buildings, boilers and air conditioning systems.
Main Office—423 West 126 Street, NYC
Offices also in Phila. and Wash., D. C.

these constituents have proved their excellence in steel cutting operations, even at severe mechanical and thermal conditions. The principal objectives of future research are improvement in thermal and oxidation resistance, and lowering of impact sensitivity and susceptibility to thermal shock, with the aim of realizing higher cutting speeds and operating temperatures.—TDD.

6.7.2, 3.5.3

Chrome Carbide for Corrosion Abrasion. *American Machinist,* **95,** No. 22, 151 (1951) Oct. 29; *Iron Age,* **168,** No. 17, 57 (1951) Oct. 25.

A family of chromium carbides, known as Series 600, have physical properties which are better in many respects than tungsten carbides. The new carbide, which contains a nickel binder, has high resistance to abrasion, erosion and corrosion, a coefficient of thermal expansion the same as that of steel and extreme resistance to oxidation, even at high temperatures. It is lighter in weight, completely nonmagnetic, harder than steel and has a compressive strength higher than most steels.—INCO.

6.7.2, 3.5.9, 3.8.4

Study of Metal-Ceramic Interactions at Elevated Temperatures. Technical Progress Report. F. H. Norton and W. D. Kingery. *Mass. Inst. of Tech.* Jan. 1, 1952. 23p. (NYO-3137).

The nature and extent of reactions at the interfaces of various metals (beryllium, silicon, titanium, zirconium, niobium, bolybdenum) with oxides (aluminum oxide, beryllium oxide, zirconium oxide (stabilized), titanium dioxide, magnesium oxide, thorium oxide) in the temperature range of 1400° to 1800° C in a neutral atmosphere have been studied. Literature data and calculations for metal-ceramic interfacial reactions indicate the general order of reaction although exact calculations are not possible with present data. Reactions may either be nonreactive or react to yield a physically unaltered surface. Specific types of reaction encountered were corrosion of the interface, formation of a new boundary phase at the interface, and a penetration and alteration of oxide properties attributed to solid solutions. Additional measurements and recalculations of surface tension have been carried out, and the effect of a iron-0.1% titanium melt has been investigated. Various results indicate that oxygen solubility strongly affects the surface tension found. A microscopic furnace for investigating sintering has been completed and is ready for operation. A description and drawing of the furnace are included.—NSA.

NACE BOOKS and PAMPHLETS

on

CATHODIC PROTECTION

•

CATHODIC PROTECTION
A Symposium
(The Electrochemical Society and the National Association of Corrosion Engineers)

Cloth, 8½ x 11, 203 pages. 23 Papers, comprehensive, authoritative information on cathodic protection from both theoretical and practical standpoints. Illustrated. Many references.
Postpaid to members of ECS and NACE, Per Copy.....$6.00
(Others, $8.00)

•

Report of the Correlating Committee On Cathodic Protection

Bulletins I, II, III and IV. Paper, 6 x 9, 33 pages. Bulletins outlining the recommendations by 11 associations and organizations operating and interested in protecting metals underground or submerged from corrosion. Data covered includes recommendations on design, notification procedures suggested when cathodic protection systems are being installed, customary technical practices and information on the operation of joint systems. Valuable appendices include selected bibliography on cathodic protection.

Copies	Each
1 to 10	50c
11 to 100	35c
Over 100	25c

Postpaid to a single address.

•

Control of PIPE LINE CORROSION
By O. C. Mudd, Chief Corrosion Engineer, Shell Pipe Line Corp., Houston, Texas.

Paper, 6 x 9, 61 pages. Thousands of copies of this booklet have been sold. It covers in easy-to-read style the theories of corrosion of underground pipe lines, tells methods of investigation, instruments required, explains electrical protection, installation of anodes and ground beds and covers the economics. Illustrated.

Per Copy, postpaid.....$1.25
(5 or more copies to one address, per copy $1)

Send Orders to
A. B. Campbell, Executive Secretary
NATIONAL ASSOCIATION of CORROSION ENGINEERS
No. 1 MAIN STREET
1061 M & M Bldg. Houston 2, Texas

BINDERY SERVICE

Readers of CORROSION who wish to have their copies of the magazine bound may apply to

ART BOOKBINDERS
616 West 19th St.
Houston, Texas

The prices listed below are quoted on binding to the following specifications only: Full green cloth, hard cover, sewed, with the name "CORROSION" and the volume number and year stamped on the back. All prices are net to the binder, transportation extra. Send your complete copies prepaid, with full instructions.

The following options are suggested:

1. Technical Section Only.....$3.50
2. Abstract Section Only.....$3.50
3. Technical and Abstract Seconds in One Cover.....$3.50
4. All Pages $4.00

Transactions are between the individual and the binder and NACE will not be a party to nor does it offer any warranty of any nature in connection with any transaction. All correspondence will be with the binder directly and all billing will be direct to the purchaser from the binder. If any specifications other than those included herein are desired, arrangements must be made with the binder for the work.

7. EQUIPMENT

7.1 Engines, Bearings, and Turbines

7.1, 2.3.9

Rate of Engine Wear Depends on Fuels and Lubes. *SAE Journal,* **60,** 24-27 (1952) Feb. Based on "Some Phenomena of Engine Wear as Revealed by the Radioactive Tracer Technique," H. R. JACKSON, F. C. BURK, L. J. TEST, and A. T. COWELL, to be published in SAE Quarterly Transactions.

Recent radioactive-tracer tests on two-single-cylinder laboratory engines indicate that: low-temperature wear increases in essentially a straight-line relationship with increasing sulfur content in fuel in the range 0-0.25% sulfur; as little as 1-2% alcohol in alcohol-gasoline blends results in a definite increase in low-temperature wear; and use of a properly compounded lubricant reduces wear at low operating temperatures.—BLR.

7.1, 3.5.9, 3.7.2

Trends in Gas Turbine Engine Materials. R. H. THIELEMAN, J. C. MERTZ, and W. P. EDDY JR., United Aircraft Corp. Paper before SAE, Ann. Mtg., 1952. *Machine Design,* **24,** No. 3, 216+ (1952) Mar.; *SAE Journal,* **60,** 58-63, (1952) Apr.

Substitution of protectively coated carbon or low-alloy steels for stainless alloys in parts which operate at low temperatures is one way to conserve elements in the production of turbojet and turboprop engines. The austenitic chromium-nickel alloys are specified for high temperature and stress. For lower temperatures, the choice between ferritic stainless steels and low alloy steels is dictated by creep values and corrosion resistance. Plain carbon or low-alloy steels can be used to conserve chromium. Discussion of coatings to aid conservation is given. In the protection of similar parts operating at temperatures above the melting point of cadmium, desirable metal plates, such as chromium and nickel, may reduce the fatigue strength of the metal. Electroless nickel plate holds promise because of the uniformity of the deposited coating. Ferritic stainless steels are necessary where high resistance to corrosion, erosion, and abrasion of operating parts must be maintained at temperatures up to 1000° F. Nickel base alloys in sheet form are used for parts in a turbine engine subject to gas temperatures from 1200-1800° F. The need for better materials is discussed. Until reliable disc-cooling techniques are developed, ferritic steel turbine discs are not feasible. Use of new alloys such as titanium and cobalt-base alloys is discussed.—INCO.

7.1, 3.5.9, 6.7.2, 6.5

Research Pushed on Gas Turbine Blade Materials. A. H. ALLEN. *Steel,* **129,** No. 9, 72-75, 101 (1951) Aug. 27.

Study of cast and forged alloys, sintered metal powders and ceramals to find replacements for niobium, tungsten, cobalt, nickel, chromium, and molybdenum and to perfect blades having longer life at high operating temperatures to improve turbo-type air engines. A typical engine requires 2000-4000 pounds of the critical metals including 400-800 pounds of nickel. Turbine noz-

PROOF

HERE'S HOW TAPECOAT®

HAS STOOD THE TEST OF TIME

TO SOLVE CORROSION PROBLEMS

PROOF (Underground) — Inspection of TAPECOATED joints after 10 years of underground service showed no sign of corrosion when the TAPECOAT was removed.

PROOF (Alternate wetting and drying) — Expense and trouble in protecting lines subject to wet and dry conditions at cooling towers have been eliminated since 1944 by coating with TAPECOAT.

PROOF (Underwater)—During the re-laying of an underwater pipe line in the Gulf area, examination showed that TAPECOAT had protected the pipe against salt water corrosion and barnacles.

PROOF (Above ground)—A gas line at a bridge crossing was TAPECOAT-protected in 1944. There has been no need for attention and *no interruption of service* since the pipe was TAPECOATED.

Actual experiences like these show what TAPECOAT coal tar protection can do for you.

Use TAPECOAT to combat corrosion above or below ground on gathering lines, transmission lines, meter stations, compressor stations, distribution lines, pipe joints, bolt-type couplings, fittings, large bends, large diameter pipe, insulated lines, tanks, and other surfaces subject to corrosion.

Write for descriptive brochure and prices

The* TAPECOAT *Company

Originators of Coal Tar Tape Protection

1521 Lyons Street, Evanston, Illinois

135a

zle vanes are usually made of stainless steel. Ceramals investigated included a mixture of titanium carbide and 5-30 nickel powder and carbide plus cobalt, iron, tungsten, and molybdenum. It has been proposed that a ceramal might make an excellent coating material for high-alloy combustion chambers of gas turbines. Experiments and results of the determination of the effect of thermal shock are outlined. The investigations of the relationship between static and fatigue properties of low carbon N-155 (20 chromium-20 nickel-20 cobalt, 32 iron), the favorable effects of some solution treatments at temperatures of 350, 2250 and 2100° F. followed by aging at 1500° F on the life of small cast cobalt-chromium AMs 5385 blades and the effects of a 48 hour aging treatment at 1500° F on the life of 20 small cast vitallium (25-20 chromium, 5-6 molybdenum, 2 iron, 1.75-3.75 nickel, 1 max. manganese, 1 max. sulfur, 0.20-0.35 carbon, bal. cobalt) are discussed. Tables showing 25 high temperature alloys, including Hastelloy B, Inconel, Inconel W and X, N 155, and Nimonic 80 and their stress-rupture properties at 4 elevated temperatures and comparative stresses for fracture in 50, 150, and 500 hours for various tests are presented. Four references.

7.1, 5.11, 3.7.3

Recent Developments in Francis Turbines. WM. J. RHEINGANS. Allis-Chalmers Mfg. Co. Paper before ASME, Ann. Mtg., Atlantic City, Nov. 25-30, 1951. *Mech. Eng.*, **74**, No. 3, 189-196, 211 (1952) Mar.

The trend in turbine design is reduction in aver-all weight and cost by using welded plate steel construction. Welded spiral casing reduces the possibility of defective material in complicated steel castings. Welded instead of riveted joints eliminate the problem of stress in large casings. Stainless steel is used for pre-welding areas where pitting occurs and for Francis runners, wicket gates, facing plates and wearing rings for high-head installations. A mild steel runner with a stainless steel overlay is cheaper than one of solid stainless steel and time in applying the overlay is reduced by using inert-gas welding. A new development is the use of stainless-steel-strips welded to the surface of mild-steel runner castings. 18-8 runners were used for 2½ years without signs of corrosion. 12-14 chromium stainless steels are more resistant to erosion than 18-8. The aluminum or Ampco bronzes are promising metals for resistance to erosion. In comparing magnesium-bronze, 18-8, and Ampco bronze runners, 18-8 replaced the magnesium-bronze runners and showed no signs of pitting. Self-lubricating bearings, and carbon seal rings to replace stuffing boxes with stainless steel sleeves, are discussed. Illustrations.—INCO.

7.1, 6.3.6, 5.8.2

Corrosion of Brass-Retainer Ball Bearings. HAYWARD R. BAKER. Naval Research Lab. 1951 Dec. 20, 9p. (NRL-3918).

Difficulty has recently been experienced by bearing manufacturers, maintenance depots, and military laboratories from corrosion of steel balls and races during storage of brass-retainer ball bearings. This corrosion has been duplicated in the laboratory and has been shown to be galvanic in nature. The rate of corrosion is accelerated by small quantities of acids formed by oxidation of a petroleum or diester or by hydrolysis of an aliphatic diester oil. The rust inhibitor, barium mahogany sulfonate, serves to accelerate the rate of corrosion by its presence. This corrosion can be greatly reduced or even prevented by using a corrosion inhibitor capable of neutralizing the acids as they are formed and thus preventing them from accelerating the rate of corrosion between the dissimilar metals.—NSA.

7.1, 6.6.8

Now: Nylon Parts for Ball Bearings. F. W. RECKNAGEL. *Product Engineering*, **23**, 119-123 (1952) Feb.

Discusses the above application for nylon and lists its advantages and properties, several of which are: noise reduction, resistance to corrosion and wear, low coefficient of friction and adaptability to lubricating conditions.—BLR.

7.1, 8.9.1, 5.4.2

How to Cut Wear on Engine Parts. *American Aviation*, **15**, No. 6, 33 (1951) July 9.

One of the more promising developments in the engine field in recent months has been service testing and laboratory experimentation with ceramic-coated heat-resistant alloys such as those used in piston engine exhaust systems and many parts of turbine engines. Both the National Advisory Committee for Aeronautics and airlines have been making headway with tests along these lines. NACA's work was carried on by the National Bureau of Standards and involved the laboratory testing of a group of five heat-resistant alloys: inconel, 347, 19-19DL, vitallium, and S-816—with and without ceramic coats when exposed to lead bromide, a by-product of combustion-type engines. The airline work has consisted of service testing of ceramic-coated engine exhaust systems on a limited scale. NBS work proved that lead bromide is a major factor in corroding these heat-resistant alloys and that, in every case tested, ceramic coatings prevented or appreciably minimized the attack. The protective value of ceramic coatings as well as the corrosive effects of high-temperature lead bromide fumes on uncoated metal are graphically illustrated. The preparation and testing of the samples are discussed.—TDD.

7.1, 4.4.7

1000-Mile Oil Change is a Must. W. F. WEILAND. *Petroleum Processing*, **7**, 69+ (1952) Jan.

Presents results of tests on lube stability vs. corrosion of engine and bearing metals. They show that incipient corrosion is definitely related to an acid-vapor temperature of 215° F or the temperature at which capors with acid characteristics are liberated in progressive oil breakdown.—BTR.

7.2 Valves, Pipes and Meters

7.2, 4.5.2, 5.2.1

Corrosion and Pipe Protection. MARSHALL E. PARKER. *American Gas Journal*, **176**, 25-28 (1952) Apr.

Underground corrosion of iron and steel. Standard electrode potentials are measured for most metals. Includes role of hydrogen anodes and cathodes, cathodic protection, pipe coatings and sacrificial anodes.—MR.

7.2, 4.6.2, 3.5.9, 3.5.7

Steam Piping for High Pressures and High Temperatures. R. W. BAILEY. *Inst. Mech. Engrs. Proc.*, **164**, No. 3, 324-350 (1951).

Discusses distribution of stress in pipes, the accompanying creep, and their application to the rational and economical design of steam piping; the determination of permissible working stress; differences in American and British procedures and consequent differences in stress magnitudes; tentative considerations of behavior of ferritic and austenitic steels, and the action of creep at operating pressure and temperature in reducing and removing the initial thermal expansion loading of a pipeline, and in imposing it fully when cold. Deals with the problem of making a joint between ferritic and austenitic steel piping and components, and factors of materials and corrosion.—BLR.

7.2, 5.3.2, 6.3.6

The British Non-Ferrous Metals Research Association. G. L. BAILEY. *Research*, **4**, 569-572 (1951) Dec.

Reviews corrosion investigations carried on by the above association on galvanized steel and copper pipes. A brief discussion of the researches on creep of metals is also given.—BLR.

7.2, 7.1, 8.9.1, 8.9.2, 6.2.1

Study of Aviation, Automotive, and Diesel Valves. A. BALLERET. Paper before A.E.R.A., Heat Resistance Materials Congress, 1951. *Metaux: Corrosion Industries*, **26**, No. 310, 256-268 (1951) June.

The steels, special metals, and the procedures to improve the tensile strength at high temperatures and to avoid wear and corrosion of valves are described. 18-8, 13.5 chromium-13.5 nickel stainless steel, Austenitique (21 nickel, 20 chromium, 1.5 molybdenum), Silchrome # 1 (13 Cr-3.5 silicon), Silchrome X.C.R. (4.75 nickel, 24 chromium, 2.75 molybdenum, 1.0 manganese), K. E. 965 (10.12 nickel, 12-16 chromium, 1.7 silicon, 1.5 manganese, 2-4 tungsten), D.T.D. 496 (10 nickel, 12-16 chromium, 2 silicon, 2 tungsten, 1.5 manganese), and T.P.A. (13-15 nickel, 13-15 chromium, 2-3 tungsten) are used as valve materials. Above 750° C, the austenitic stainless steels are subject to intercrystalline corrosion. To prevent high temperature oxidation of the valve heads, a Brightray (19.75 chromium, 76.4 nickel, 2.2 iron, 1.77 manganese) coating, or chromium or stainless steel plating is applied.—INCO.

7.2, 8.4.3

Duplex Tubing for Use in the Petroleum Industry. C. L. BULOW (Bridgeport Brass Co.) *Petroleum Engineer*, **23**, No. 10, C5-C8 (1951) Sept.

Applications of duplex tubing as a solution to dual corrosion problems. Stainless tubes have failed from transcrystalline stress corrosion cracking in contact with certain cooling waters. Where cracking has occurred from the outside in atmospheric coolers copper alloy clad stainless tubes have been used. Stainless steel clad copper tubes are being used to withstand corrosion by impinging high velocity vapors. In coolers handling amines and mixtures containing amines, low carbon steel lined with Admiralty and various cupro-nickel alloys and aluminum brass have performed satisfactorily, particularly where

gulf or bay waters are used for cooling. 70/30 and 80/20 cupro-nickel, aluminum brass and bronze and Admiralty brass are usually combined with steel where sea water is used for cooling ammonia. Duplex tubing is finding increasing use in condensers, heat exchangers and coolers for handling numerous corrosive gases where the general or impingement corrosion resistance of low carbon, chromium or stainless steel, tin, Monel, aluminum, nickel and lead combined with copper alloys are required. Illustrations.—INCO.

7.3 Pumps, Compressors, Propellers & Impellers

7.3, 3.7.2, 6.3.6, 4.6.11

Marine Propellers. G. T. CALLIS. *Metal Ind.*, **79**, No. 9, 167-170 (1951) Aug. 31.

Manganese-bronzes in current use for marine propellers are placed in two groups. The first type contains 1 tin with between 0.3-0.7 aluminum; the second contains a maximum of 0.5 tin with about 2 or more aluminum. Greatest difference between the alloys is found in their behavior in clean and contaminated sea water. Aluminum-bronzes which have proved to be most suitable for large marine propellers contain both nickel and iron. It has been shown by cavitation test methods, believed to induce typical erosion damage, that the aluminum-bronzes exhibit a high resistance to damage, comparable with that of the austenitic stainless steels, and markedly superior to the manganese-bronzes. Photomicrographs and pictures are included. 4 references.—INCO.

7.3, 8.9.5

Corrosion of Axle Shafts and Propeller Screws of Ships. (In French.) Circulaire d'Informations Techniques, Published by Centre de documentation sidérurgique (Paris). **8**, 1415-1419 (1951) Dec.

Discusses the above briefly, as observed on the "Rex" and the "Normandie," presenting causes and remedies. Materials discussed include cast irons, carbon and alloy steels, and manganese bronzes.—BLR.

7.4 Heat Exchangers

7.4.2, 5.8.4

Protecting Condensate Piping, Heating Units Against Corrosion. G. A. MIERENDORF. (A. O. Smith Corp.) Paper before 1st Ann. American Power Conf., sponsored by the Ill. Inst. of Tech. *Heating, Piping & Air Cond.*, **24**, No. 5, 92-95 (1952) May.

Corrosion in condensate return lines, steam traps and heating units represents a hidden cost of maintenance in steam heating systems. The deposits and contamination resulting from this corrosive action are also reflected in sluggish heating operation and damage to boilers. The selection of filming amines to correct these problems in the plants was based on the results obtained in comparison to other materials used.—INCO.

7.4.2, 8.4.3, 8.8.1, 6.2.5, 6.3.10

Corrosion in Amine Gas Treating Plants. F. C. RIESENFELD and C. L. BLOHM. Paper No. 50-PET-16 presented at the Petroleum Mechanical Engineering Conference of the American Society of Mechanical Engineers, New Orleans (U.S.A.) 23 pages, 25-28th September 1950. *Petro. Ref.* **30**, 97-106 (1951).

The results of experimental work done with small and full scale heat exchangers containing tubes of various steels and alloys are presented in this paper. The work indicates that in glycol-amine plants, 4-6 chromium ½ molybdenum steel and aluminum alloy 3S are suitable for the manufacture of heat exchanger tubes. Types 304 and 316 stainless steel, Monel, Inconel and Carpenter 20 steel were found to be corrosion resistant in systems using aqueous amine solutions. A general discussion of corrosion of carbon steel in both aqueous and glycol-amine gas treating plants, based on information gathered from a large number of installations, is also presented. (Authors' summary.)—ALL.

7.5 Containers

7.5.5, 3.6.6, 4.6.6, 5.3.2

The Corrosion of Domestic Galvanized Hot Water Storage Tanks. I. LAIRD NEWELL, Henry Souther Engineering Co., 11 Laurel St., Hartford, Conn. *J. New England Water Works Assoc.*, **65**, No. 1, 71-87 (1951) Mar.; *Corrosion*, **9**. No. 2, 46-51 (1953) Feb.

After a general discussion of factors which lead to zinc becoming cathodic to steel in hot water tanks the author relates instances pointing to the presence of copper as being a principal agent in the rapid dissolution of zinc protective coatings exposed to heated water. The copper appears to deposit as small metallic particles on the surface of the zinc, forming galvanic cells which lead to rapid pitting. As little as 0.1 ppm copper causes a definite increase in corrosion rate. Examples of six galvanized water tanks in use for periods from 431 to 667 days are given. The author concludes lower corrosion rates can be secured by using all-galvanized systems, by removing carbon dioxide, by removing copper from water or lowering operating temperature to prevent potential reversal. Discussion relates case histories tending to place blame for rapid corrosion in galvanized water heaters on copper piping.

7.5.5, 5.2.1

Experiments in Cathodic Protection for Large Storage Tank Bottoms. L. A. SNYDER. Part of Paper, Calif. Natural Gasoline Assoc. Meeting. *Gas*, **28**, No. 1, 44-45 (1952) Jan.

Three kinds of cathodic protection were applied to 80,000 bbl. tank; 1) five 2-in x 80-in. graphite anodes, with graphite backfill were spaced 60-ft. from the tank and equidistant around it; 2) an out-of-service buried pipeline, about 300 ft. from the tank, was used for an anode; 3) 8-in. holes 56 ft. long were drilled at a 30° angle under the tank. Five 2-in. x 8-in. graphite anodes with graphite backfill were placed in the hole and backfilled with soil mixed with salt water. The third method, which showed a more positive equal distribution of current with more equal potentials between the center and perimeter of the tank, was applied to protect nine 100,000 and three 80,000 bbl. tanks, spaced approximately on 350-ft. centers. Installation is described completely with diagrams showing anode details and arrangement. Average installation cost/tank was $1500.00.

7.5.5, 5.4.3, 8.4.3

Inner Coating a Corroded Gasoline Storage Tank With Concrete. E. H. TANDY. Standard Oil of California. *Corrosion*, **8** (News Section), No. 5, 1 (1952) May.

Prior to applying the concrete to the corroded gasoline storage tank, the shell was sand blasted and a galvanized wire mesh installed. A 1½ inch thickness of concrete was then blown over the mesh and the surface steel-troweled to provide a smooth surface for the floating roof shoes.—INCO.

7.6 Unit Process Equipment

7.6.4, 7.2, 6.3.6, 5.3.2

Rust and Scale Prevention in Hot-Water Plants. G. SEELMEYER. *Werkstoffe u. Korrosion*, **2**, No. 1, 17-30 (1951); *J. Inst. Metals, Met. Abs.*, **19**, Pt. 8, 608 (1952) Apr.

Review of the causes and prevention of rusting and scaling in hotwater plants. Preventive methods include the use of copper, copper-nickel alloys, galvanized iron, and copper or aluminum-clad steels as constructional materials. 34 references. —INCO.

7.6.4, 5.9.2

Chemical Removal of Copper from Boilers. R. G. CALL AND W. L. WEBB. *Trans. Am. Soc. Mech. Engrs.*, **73**, 125-133 (1951) Feb.

When acid-cleaning a 1,000,000-pound per hour boiler for removal of deposits which were predominantly iron oxide, the boiler metal was heavily plated with copper. During subsequent operation this copper became detached in large sheets which affected circulation adversely, making copper removal mandatory. A solvent was developed containing ammonium per sulfate, ammonium hydroxide and sodium hydroxide which removed about 300 pounds of copper. Procedures, results, and costs are indicated.—BLR.

7.6.6, 8.5.3

Digester Corrosion, Experience of a Sulphate Mill. T. C. JOHNSON, Union Bag and Paper Corp. Paper before T.A.P.P.I., Annual Meeting, N. Y., Feb. 20-23, 1950. *Tappi*, **33**, No. 10, 481-484 (1950) Oct.

Study of the corrosion problems experienced in 20 digesters at the Union Bag and Paper Corp.'s Savannah plant. All digesters installed were purchased under the same specifications (0.30 C, 0.80 Mn, 0.035 P, 0.04 S, 0.35 Cu steel) but new digesters corroded so rapidly that a life of 3-5 years is all that can be expected. Original digester service was from 12-14 years. Steel specified was ASME S-1, and SA-70, and ASTM A-70 and A-285. Type 316 stainless steel steam nozzles on the original digesters were replaced with extra heavy steel pipe. 3 digesters are currently being installed using ASTM A-212 steel. Stainless steel clad digesters can be justified if they will last 10 years. Illustrations. —INCO.

7.6.4

Boiler Tubes—What Can Happen and What to Do. H. M. SPRING and J. G. SYLVESTER. Mutual Boiler & Machinery Insurance Company. Southern Power and Industry, **70**, No. 2, 61 (1952) Feb.

There are many possible causes of

boiler tube failures. The common types of failures are discussed with suggested measures for correcting the conditions that may lead to trouble. Fireside damage to tubes can be caused by external corrosion or erosion, soot or slag deposits, or excessive furnace temperatures. Waterside trouble may be caused by pitting and corrosion of the tube metal or by deposit formation. Proper boiler water treatment carefully controlled will eliminate these types of troubles. Tube failures can also be caused by improper boiler design, construction, or poor operations.

Pictures included show tubes that have failed from various causes and proper procedures for repairing and replacing failed tubes. The use of the Schroeder Embrittlement Detector for determining the embrittling characteristics of the boiler water is also discussed.—NALCO.

7.6.4, 5.8.2, 5.7.1

How to Protect Your Stand-By Boilers. R. B. CONLAN (W. H. and L. D. Betz, Philadelphia.) *Paper Ind.*, **33**, 799-800 (1951) Oct.

Two general procedures, dry storage and wet storage, can be employed in laying up idle boilers to protect the metal surfaces from corrosion.

Dry storage is recommended when the boiler is to be out of service for longer than 1 month and when sufficient time will be available to prepare the unit for further service. This method is suitable where freezing temperatures may be expected during the stand-by period.

A moisture-adsorbing material such as quicklime, in amounts of approximately 30 lb. per each 100 boiler hp., should be placed in the boiler immediately after the drying-out process. Adsorbents such as silica gel and alumina are more conveniently handled than quicklime and give satisfactory results. Approximately 4 lb. silica gel are needed for each 100 cu ft of air space; however, specific recommendations should be obtained from the manufacturer of the product. After placing the adsorbent in position, all boiler openings should be closed or blanked to exclude as much air as possible. The boiler should be examined after 3-4 months and more drying agent added if needed.

Wet storage is desirable where boilers are to be left idle for longer than a week and when plant operating conditions demand emergency service. It is not suitable, however, for boilers exposed to freezing temperatures. Materials such as sodium sulphite and caustic soda and in some instances chromates are employed. To maintain alkalinity in excess of 400 ppm and a minimum residual sulfite concentration of 100 ppm, approximately 3 lb caustic soda and 1.5 lb sodium sulfite, respectively, are required for each 1000 gal water. Where chromates are used, a sufficient amount should be added to give chromate concentrations of 500-1000 ppm. It is generally more economical to employ technical granular sodium dichromate $Na_2Cr_2O_7.2H_2O$: for each 100 lb of this chemical, approximately 27 lb of caustic soda are required to give a pH of 7.5-9.5.

At weekly intervals water tests should be made and alkali and sulfite increased if necessary. Test strips can be suspended at various locations and examined monthly to determine degree of protection obtained.

Other methods of protection include protective coatings and paints. These should be employed in conjunction with one of the regular chemical methods of storage. In Germany, boilers that are to remain idle for a long time are reportedly dried, filled with ammonia gas, and hermetically sealed.—PDA.

7.7 Electrical Telephone and Radio

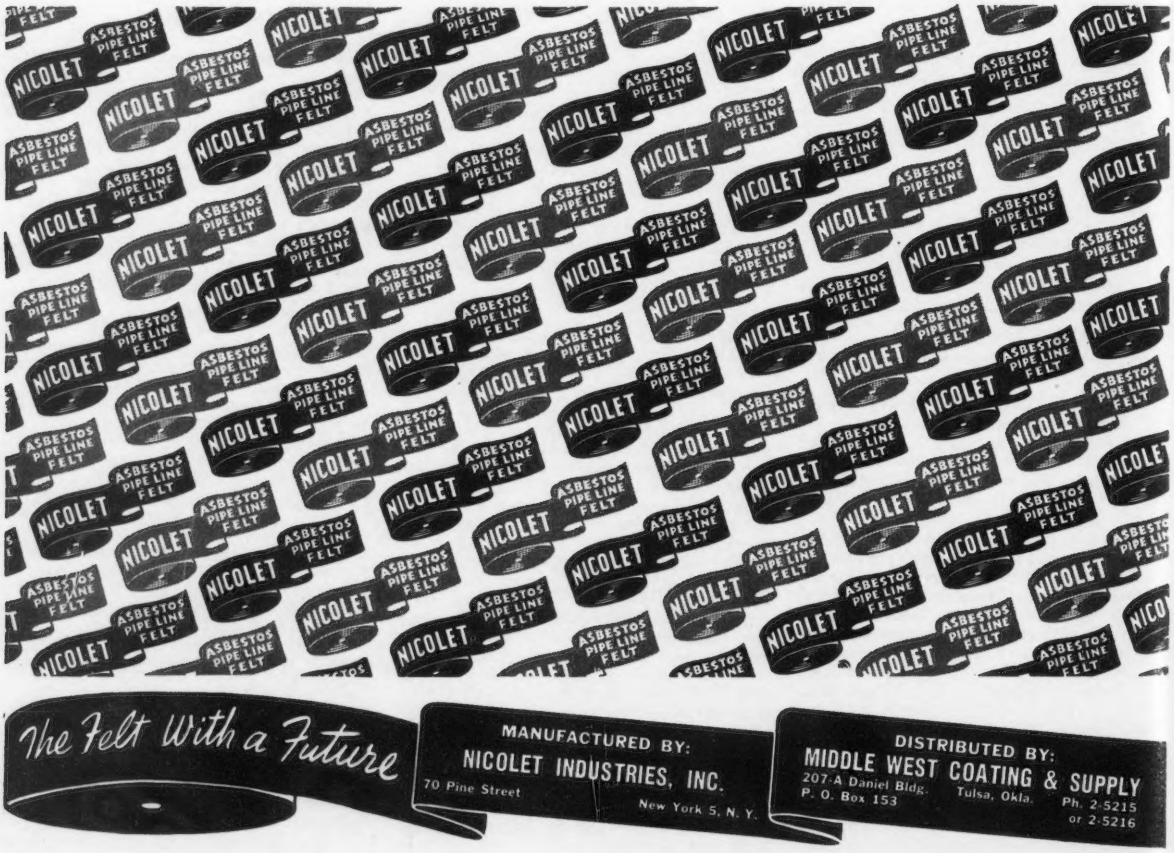
7.7, 5.4.5

Transformers Last Twice as Long With New Paint System. *Paint Progress*, **9**, No. 1, 8 (1951).

A paint treatment which, it is said, makes transformers last twice as long comprises: (1) a phosphate coating applied to the degreased steel transformer, tanks followed by a dip in chromic acid, (2) a rust-inhibitive primer pigmented with zinc chromate and ferric oxide in a

CORROSION ABSTRACTS

Will Be Indexed by Topics and Page Numbers in the December Issue.



BOOKS, PAMPHLETS and REPRINTS of MATERIAL on CORROSION

● BOOKS

Joint Symposium on Cathodic Protection
Postpaid to members ECS and NACE, per copy ..... $ 6.00
To all others, per copy 8.00

Bibliographic Survey of Corrosion, 1945
Postpaid to NACE members, per copy ..... $ 4.00
To others, not NACE members, per copy 5.00

Bibliographic Survey of Corrosion, 1946-47
Postpaid to NACE members, per copy ..... $ 7.00
To others, not NACE members, per copy 9.00

1945 and 1946-47 Bibliographies Combined
Postpaid to NACE members ... $ 9.00
To others, not NACE members .. 12.00

● BOOKLETS

Control of Pipe Line Corrosion by O. C. Mudd
Per Copy, postpaid ..... $ 1.25
(5 or more copies to one address, per copy, $1)

Report of the Correlating Committee on Cathodic Protection
1 to 10 copies, each 50c
11 to 100 copies, each 35c
More than 100 copies, each 25c
Postpaid

Symposium on Sulfide Stress Corrosion
Publication 52-3
Per Copy, postpaid ..... $ 1.00
(5 or more copies to one address, per copy, 50c)

NACE Committee Directory
Publication 52-2
Per Copy, postpaid, members ... $ 1.00
(Non-members of NACE, $2)

● TECHNICAL REPORTS

TP-3 First Interim Report on Ground Anode Tests
Publication 50-1
Postpaid to NACE members, per copy ..... $ 3.00
To others, not NACE members, per copy 5.00

TP-2 First Interim Report on Galvanic Anode Tests
Publication 50-2
Postpaid to NACE members, per copy ..... $ 3.00
To others, not NACE members, per copy 5.00

TP-1 Report on the Field Testing of 32 Alloys in the Flow Streams of Seven Condensate Wells
Publication 50-3
Postpaid to NACE members, per copy ..... $ 8.00
To others, not NACE members, per copy 10.00

Report of TP-12 on Electrical Grounding Practices* ..... .50
First Interim Report of TP-6G on Surface Preparation of Organic Coatings. Publication 50-5 ..... .50
Second Interim Report of TP-6G—Surface Preparation of Steels for Organic and Other Coatings. Publication 53-1. Per Copy .. 1.00
(5 or more copies to one address, per copy, 50c)
Report of TP-5C Sub-Surface Corrosion by Alkaline Solutions.* "Stress Corrosion Cracking in Alkaline Solutions." Publication 51-3 ..... .50
Report of TP-1 on Sour Oil Well Corrosion, per copy ..... .50

** Available only in limited supply.*

● REPRINTS

Cathodic Protection and Pipe Lines
Mitigation of Corrosion on City Gas Distribution Systems by A. D. Simpson, Jr. .50

Paints and Coatings
Gasoline Resistant Tank Coatings by W. W. Cranmer ..... .50
Tests, Properties of Corrosion Preventive Lubricants for Lead Sheathed Cables in Underground Ducts—A Discussion by Howard S. Phelps and Frank Kahn .... .50

Petroleum Production and Storage
Corrosion in Condensate and in High Pressure Sweet Oil Wells by R. C. Buchan .. .50
The Use of Ammonia in Control of Vapor Zone Corrosion of Storage Tanks* by F. T. Gardner, A. T. Clothier and F. Coryell ..... .50

Miscellaneous
Causes of Corrosion in Airplanes and Methods of Prevention by N. H. Simpson .... .50
Salt Spray Testing Bibliography by Lorraine Voight ..... .50
The Cost of Corrosion to the United States by H. H. Uhlig ..... .50
Why Metals Corrode by H. H. Uhlig ..... .50
Corrosion Control by Magic—It's Wonderful by H. H. Uhlig ..... .50
Index to Volume 8 ..... .50

● SINGLE COPIES OF CORROSION

Single copies of Corrosion are available at 50c a copy to NACE members and $1 a copy to non-members, postpaid.

Copies of all issues are available except:
1947—January, March, July, September, November
1948—February, May, June, July, August, December
1949—January, February, July, August, September, October
1950—January, February, April, May, July, August, December
1951—January, February
1952—March

Indices to Corrosion technical literature have been published as follows:
5-Year Index, 1945-49 inclusive and Index to Vol. 6, 1950 ..... December, 1950
Index to Vol. 7 ..... December, 1951
Index to Volume 8 ..... December, 1952

Address Orders and Remittances to

NATIONAL ASSOCIATION of CORROSION ENGINEERS

HOUSTON **1061 M & M Building** **TEXAS**

stoving vehicle, (3) water-ground mica in a vehicle of modified phenolic and alkyd resins, a green fugitive dye being incorporated to assist in even application, (4) a dark grey finish coat, salt-air- and weather-resistant, formulated to chalk at a desirable rate. It is believed that similar systems will fit other requirements, e.g., car undercoatings.—RPI.

8. INDUSTRIES

8.1 Group 1

8.1.2, 2.2.2, 6.4.2

Weathering of Sheet Metal Building Material. *Technical News Bulletin, National Bureau of Standards,* **36,** No. 5, 72-74 (1952) May.

The complete report was published as "Atmospheric exposure tests of nailed sheet metal building materials," BMS 128. Sheets of aluminum and zinc alloys and of aluminum-coated and galvanized steel were exposed to the weather under conditions closely approximating those found in actual practice. Each metal tested was fastened to bare wooden boards with nails of various materials, both with and without Neoprene or lead sealing washers between the nail head and the sheet. Results of two years' exposure indicate that any uncoated nail except aluminum, can cause serious corrosion of the surrounding aluminum. The cadmium and zinc coated nails caused no corrosion, unless the coating showed signs of wearing away. Carbon-black-filled Neoprene washers were found to weather better than ordinary Neoprene washers in the test; the latter tended to harden. All the sheets investigated showed only very slight corrosion due to the atmosphere alone—at a distance from the nails—at the end of the two year period.—ALL.

8.4 Group 4

8.4.3, 2.1.2

Evaluation of Corrosion in Producing Wells. M. E. PARKER. *Oil Gas J.,* **50,** No. 49, 191 (1952) April 14.

Waiting until failures occur, periodic tubing surveys and observing side effects such as recording iron content in water are methods of discovering corrosive conditions in a new well. Weighed samples are used to check the aggressiveness of fluid, selection of special alloys where these are necessary, comparing inhibitors and to determine the proper feeding rate for inhibitors or other chemical agents. The best methods are pooling data and correlated programs of investigation and of search for remedial measures.—INCO.

8.4.3, 4.6.12, 5.1

New Light on How to Combat Corrosion in Water-Flood Operations. F. A. PRANGE. Phillips Petrol. Co. *Oil Gas J.,* **50,** No. 49, 148+ (1952) Apr. 14.

Discussion of hydrogen sulfide, carbon dioxide, and hydrogen and their effects on steel and cast iron, electrochemical currents and ringworm corrosion which is related to the microstructure of steel as corrosion factors. Other factors are mechanical removal of protective scales such as calcium carbonate and air which causes the formation of sulfuric acid which attacks steel in a stock tank. Since steel is composed of dissimilar metals, it does not have to be coupled to a dissimilar metal. Coatings, inhibitors such as Kontol, graphitization, ceramics, asbestos cements and alloys such as stainless steels, copper alloys and aluminum bronzes are considered for corrosion control. Other methods suggested are changing the nature of the corrosive agent and control or elimination of hydrogen. Operators of distillate wells are experimenting with a 5 and 9 nickel and 5 and 9 chromium steel for alloy tubing. Photograph.—INCO.

8.4.3, 5.1, 1.3, 4.1

Practical Answers to Corrosion Questions. J. C. REIDEL. *Oil and Gas J.,* **50,** No. 45, 203-210+ (1952) Mar. 17.

Practical answers dealing with engineering corrosion questions are given by experts with major oil companies. Corrosion types—causes and prevention including graphitization, steel embrittlement and hydrogen attack; cathodic protection—condensers and heat exchangers; materials used to fight corrosion including clad steels, chromate inhibition and protective coatings; applications—equipment and environment including handling of sour crude and acid sludges, tank corrosion both interior and exterior, boiler corrosion and pipeline corrosion; and corrosion testing are discussed. Diagrams and 28 references are given.—INCO.

8.4.3, 5.4.5, 4.3.1, 4.4.1

Plastic Coatings Aid Refiners in Fight Against Corrosion. F. L. RESEN. *Oil and Gas. J.,* **51,** No. 2, 124-127 (1952) May 19.

Plastic coatings are resistant to organic solvents and acids, most inorganic acids and salts and to mixtures of organic and inorganic chemicals. Inorganic acid is less prone to attack the coating in the presence of hydrocarbons than when equivalent acid concentrations are in contact with the coating.* The coating was applied to combat corrosion in refining and chemical equipment. It was used in tanks, piping, pumps in chlorinated aromatic hydrocarbons with traces of moisture, heat exchangers and valves. Pipes fabricated in straight sections using seamless-steel tubing and slip-on flanges are recommended. Typical applications, service record, plastic application, and general uses are discussed. Illustrations.—INCO.

*One type being used is a baked phenolic formaldehyde.

8.4.3, 5.7.7

Ammonia for Acid Corrosion in Refineries. M. E. PARKER. *Oil Gas. J.,* **50,** No. 37, 114 (1952) Jan. 21.

Various alkaline neutralizers are used for the reduction of the hydrogen ion concentration responsible for acid corrosion. A prime advantage of ammonia is that it may pass through part of the stream as a vapor and condense where condensed acidic water is causing difficulty. It is volatile so that strongly alkaline solutions can not be locally concentrated by evaporation. Pump injection of ammonia water is used where the pressure in the vessel exceeds the vapor pressure of the ammonia. Ammonia controls corrosion by hydrogen sulfide gas and it is established that a relatively small amount of ammonia is adequate to reduce sulfide corrosion to the vanishing point. Four references.—INCO.

8.4.3, 5.8.2

Corrosion Solution. T. S. ZAJAC, Shell Oil Co., N. Y. Paper before Natural Gasoline Assoc. of Am., Ann. Mtg., Houston, April 30-May 2, 1952. *Oil Gas J.,* **50,** No. 51, 157 (1952) May 5.

Gas-condensate well-corrosion problem now under control but method costs can be cut. A cooperative effort over the years has resulted in discovery of suitable alloys for well-head assemblies and for special installations, and satisfactory chemicals for use as neutralizers and inhibitors. Several tubing alloys and coatings are in wide-spread use and their performance indicates that they will be economic solutions to the tubing-corrosion problem.—INCO.

8.4.3, 5.8.2, 5.7.7

How Six Plants Cut Corrosion Rates by 95%. W. C. UHL. *Petroleum Processing,* **7,** No. 2, 190-197 (1952) Feb.

Corrosion in refineries and natural gasoline plants is successfully being whipped by Kontol, a new type of organic inhibitor. The inhibitor stopped corrosion in a debutanizer exchanger which consists of a bundle of common steel tubes which underwent severe corrosion due to hydrogen sulfide in brine. Its use in lowering corrosion in a gasoline recovery unit, a gasoline stream, in a natural gasoline plant, in a steam stripper, and the successful combination of the inhibitor and ammonia are discussed. The inhibitor does not replace measures used in refineries, such as ammonia injection and other means of pH control, but when used with other methods it lengthens the life of equipment in corrosive service. Eight tables, 5 diagrams.—INCO.

8.4.3, 6.3.6

How to Make Brass Liners Work. WILLIAM C. UHL. *Petroleum Processing,* **7,** 475-477 (1952) April.

Brass linings are used to provide satisfactory corrosion resistance in lines and vessels carrying gasoline liquid and vapor. Sketches show some of the methods Sun Oil Co. worked out and applied in lining process lines, vessels, and fittings.—BTR.

8.4.3, 6.3.10, 5.2.1, 5.8.2

Corrosion of Subsurface Equipment in Producing Wells. M. E. PARKER. *Oil Gas J.,* **50,** No. 48, 137 (1952) April 7.

Injection of chemicals for conditioning of the corrosive fluid, use of corrosion-resistant alloys such as nickel alloys for components or as platings and linings, nonmetallic coating and/or lining materials, and cathodic protection for preventing corrosion in well are discussed.—INCO.

8.5.3, 6.6.8, 6.7.4

Fabric Base Phenolic Laminate Used Many Places in Paper Mill. *Product Eng.,* **23,** No. 5, 130-132 (1952) May.

To take advantage of the moisture and wear resistant qualities of fabric base phenol laminates, the Taylor Fibre Co. made liberal use of this material for machine components in the paper making section of their plant. By replacing steel springs on the screen tank and the steel vacuum covers with the phenolic laminate, a severe rust problem was eliminated. Diagram and photographs are given.—INCO.

8.8 Group 8

8.8.1, 2.4.2, 6.3.10

New Continuous Acid Analyzer for Sulfuric Acid. Alkylation Plants. C. L. PERSYN. Tide Water Associated Oil Co. *Petroleum Refiner*, **31**, No. 1, 91-93 (1952) Jan.

A considerable amount of corrosion was experienced in the first model of the analyzer that was constructed of steel. A steel heater coil has a life of two months and the basket holding the raschig rings would last 2-3 months, whether constructed of steel or stainless steel. The finned cooler lasted for six months, while the entire analyzer was ready to be rebuilt after one year of service. The present model is of Hastelloy B constructed for those parts that come in contact with the sulfuric acid. This portion starts with the heater coil and ends with the circular trough around the hydrometer vessel. All connections are welded, using Hastelloy B welding rod. The flow control valve has Hastelloy B seat plug and stem.—INCO.

8.8.1, 5.3.2, 5.3.4

Lead in Modern Chemical Construction. KEMPTON H. ROLL. *Chemical Engineering*, **59**, 281-282+ (1952) Jan.

Latest techniques and improvements in the above are discussed. Includes methods of supporting sheet lead, new methods of testing lead linings and welds, lead bonded to steel, lead-covered copper or steel heating coils, and use of acid-proof brick with an impervious lead interliner.—BLR.

ROSKOTE cold-applied anti-corrosion mastic saves time...saves money...SAVES PIPE!

Roskote's drying speed, its handling ease and its high electrical resistivity makes it the ideal mastic for pipeline protection, winter or summer. Whether you are protecting distribution and service lines, or large transmission lines in yard or field, it will pay you to investigate . . .

ROSKOTE

cuts field costs because it is applied COLD — either brush, spray or special line-traveling machine — without primer or field mixing. It eliminates labor, equipment and hazards of hot-applied materials. It is fast-setting to a tough, flexible film of high electrical resistivity (20 megohms per sq. ft.) without brittleness or sag through a temperature range of —40° to 375°F. It dries to the touch in 20 minutes and is ready for backfill in an hour.

Roskote's resin base resists acids, alkalies, salts and moisture. It bonds readily to previous coatings of coal tar or asphalt. Wire brushing is the only preparation needed for old pipe.

Roskote's drying speed and handling ease cuts man-hours from work schedules and speeds pipe-line progress. That saves real money! Yet Roskote costs only 3¢ per square foot of coverage.

Used by over 70 utilities and pipeline companies for coating at "hot spots," road crossings, for valves, joints, meters, drips; for patching and for waterproofing concrete regulator pits.

• •

Write for bulletin containing complete technical specifications, chemical and electrical properties and application information. Ask for the Roskote special trial order offer.

ROYSTON
LABORATORIES, INC.,
BLAWNOX, PA.

MANUFACTURERS OF QUALITY INDUSTRIAL COATINGS RESISTANT TO CORROSION BY ACIDS, ALKALIES, ELECTROLYSIS, HEAT, MOISTURE AND WEATHER.

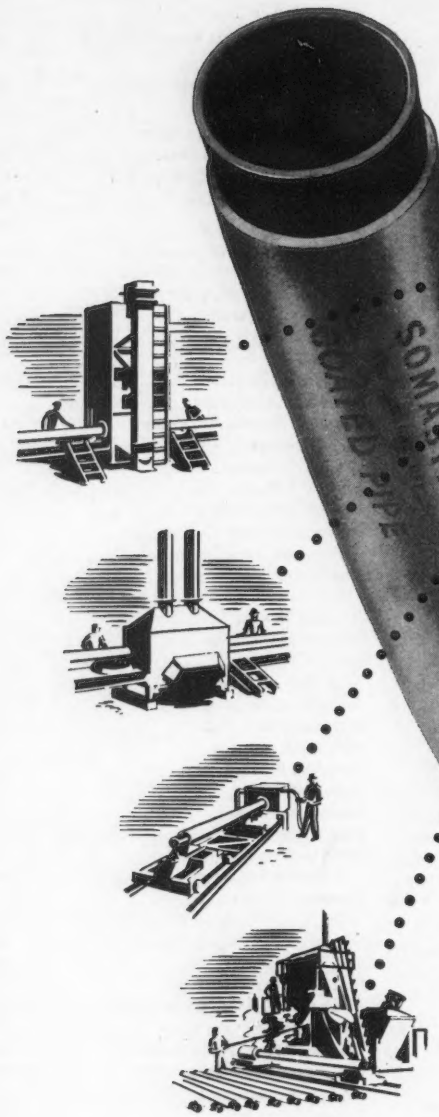
INDEX TO ADVERTISERS

Vol. 9 JUNE, 1953 No. 6

	Page
Alloy Steel Products Co., Inc.	i
Amercoat Corporation	Inside Front Cover
American Cast Iron Pipe Co.	34
American Chemical Paint Company	27
Arco Rubber Processors Div. Automotive Rubber Co., Inc.	49
Art Bookbinders	54
Bakelite Company, Div. Union Carbide & Carbon Corp.	37
Bechtel Corp. & H. C. Price Co.	62
Brance-Krachy Co., Inc.	39
Calgon, Inc.	xi
Carboline Company	8
Carpenter Alloy Tube Division	47
Cathodic Protection Service	x
Chemical Corporation	28
Coast Paint & Lacquer Co.	23
Cooper Alloy Foundry, Inc.	29
Corrosion Directory	52, 53
Day, S. D. Company	5
Dearborn Chemical Company	41
Dow Chemical Company	ii
Dresser Industries, Inc.	ix
Duriron Company, Inc.	Inside Back Cover
Electro Rust-Proofing Corp.	7
Federated Metals Division, American Smelting & Ref. Co.	3
Haynes Stellite Company, Div. Union Carbide & Carbon Corp.	xii
Hercules Powder Company	xiii
International Nickel Co., Inc.	vii, 11
Illium Corp.	6
Insul-Mastic Corp.	25
Johns-Manville Sales Corp.	35
Mayes Brothers, Inc.	12
Metalweld, Inc.	51
Michigan Pipe Company	18
Miller, Ray, Inc.	ix
Monsanto Chemical Company	45
Mutual Chemical Company of America	9
National Association of Corrosion Engineers	54, 59
National Carbon Company, Div. Union Carbide & Carbon Corp.	17
Nelson Electric Manufacturing Co.	20
Nicolet Industries, Inc.	58
Pipe Line Service Corp.	19
Pittsburgh Coke & Chemical Co.	xv
Plastic Eng. & Sales Corp.	32
Positions Wanted and Available	53
Richardson-Allen Corp.	22
Royston Laboratories, Inc.	61
Ruberoid Company	38
Saran Lined Pipe Company	vi
Service Engineers, Inc.	14
Solvay Process Div., Allied Chemical & Dye Corp.	43
Standard Magnesium Corporation	24
Stearns, D. E. Company	Back Cover
Tapecoat Company, The	55
Tnmec Company, Inc.	10
Tretolite Company	xiv
Tube-Kote, Inc.	36
United Chromium, Inc.	31
United States Stoneware Company	15
Wilkinson Products Co.	4
Williamson, T. D., Inc.	13

SOMASTIC* PERMANENCE

includes TIME TESTED METHODS of Application



For the past 23 years SOMASTIC PIPE COATING has been applied to pipe by standard practices which only now are being adopted generally by the pipe coating industry. Time has proved them most effective. These methods are—

★ *Thorough cleaning of metal by grit-blasting.*

★ *Pre-heating, followed by hot priming, assuring a firm, lasting bond of coating to steel.*

★ *Selection of materials and manufacture of coating to rigid specifications.*

In addition, SOMASTIC leads in this essential feature—

★ *Application of coating to primed pipe in a continuous process by special* SOMASTIC *equipment to form a dense, compact, uniform and seamless protective coating of great durability.*

The general swing to methods pioneered by SOMASTIC Pipe Coating is another acknowledgment of a fact first shown by the API-Bureau Of Standards Ten Year Pipe Coating Tests . . . and since proved at thousands of corrosive locations . . . for *permanence* coat with SOMASTIC.

SOMASTIC
*Reg. U. S. Patent Office
PIPE COATING

Unequaled for PERMANENT PROTECTION

SOMASTIC IS The Best PIPE COATING

MANUFACTURED BY

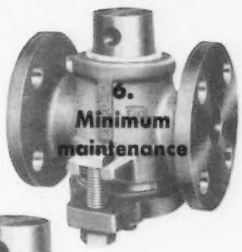
H. C. PRICE CO.
BARTLESVILLE, OKLAHOMA
PHILADELPHIA, PA. • NEW ORLEANS, LA.
In the 37 States East of the Rocky Mountains

BECHTEL CORPORATION
SAN FRANCISCO and WILMINGTON
CALIFORNIA
In the 11 Western States and in Foreign Countries

142a

The one chemical service valve

seven ways better



In the past, just one or two of these advantages were enough to justify the use of a particular chemical service valve. Now DURCO engineers have designed a valve with all seven features. With several thousand in operation in the three years since they were introduced, the list of successful applications is large and varied. If you have a troublesome corrosion problem, call the DURCO representative near you, or write The Duriron Company, Inc., Dayton, Ohio.

DURCO TYPE F VALVE

corrosion resisting with Teflon®* Sleeve

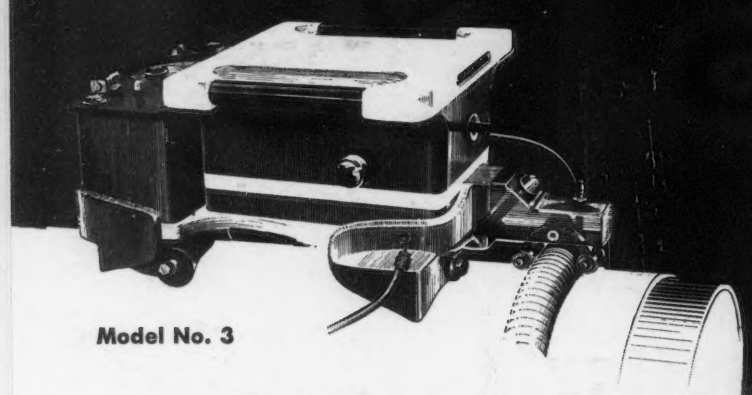
Available in ¼" through 2" flanged and screwed.

DURCO
CORROSION RESISTING ALLOYS & EQUIPMENT

**Registered trade-mark of E. I. duPont de Nemours & Co., Inc., for its tetrafluoroethylene resin.*

THE DURIRON COMPANY, INC., Dayton, Ohio

The STEARNS ELECTRONIC HOLIDAY DETECTOR



Model No. 3

for making high voltage electrical inspection of pipe line coatings, above ground, as the unit is rolled along on the coated pipe by an operator. The complete Unit consists of the Generator coupled with an Alarm System, the Rolling Coiled Spring Exploring Electrode and Pusher Carriage Assembly. A small 6-volt storage battery serves as the power source.

THOROUGH INSPECTION

Fundamental precepts which are met by the Stearns Detector are:

(1) To generate a high voltage pulse of short duration regulated to hold the crest *intensity* within narrow limits irrespective of pipe size and the variable moisture conditions experienced during field inspection;

(2) To cause such a pulse to re-occur at a *rate* rapidly enough so as to have entirely traversed the coating surface with successive overlapping circumferential bands of ionization as the testing electrode is moved along the coated pipe;

(3) To *apply*, in a simple manner, these testing pulses to the coating by means of an exploring electrode embracing and self-conforming to the variable shape of the exterior of the coated pipe while being held in electrically effective contact with the coating surface at all times; and

(4) To give out audible and visual alarm signals as an instantaneous response actuated by the formation of a spark between electrode and pipe upon encountering a fault in the coating.

Under these principles the Stearns Detector in operation approaches the ideal in testing technique, with maximum safety to the operator, by providing thorough one-pass coverage while uniformly subjecting the coating only to the extent of electrical stress necessary to ensure complete inspection.

LIGHT WEIGHT

The Stearns Detector is fabricated from the lightest materials available having the required mechanical and electrical strength. The complete unit weighs 28 pounds — is 13.5" long, 9" wide, 7.5" high. A welded magnesium case for the Detector, and a wooden box for two 10-pound 6-volt batteries serve as sturdy containers for storage and shipping. The complete shipping weight, including an overnight battery charger, is 75 pounds.

SIMPLE TO OPERATE

The Stearns Detector can be operated without special training or experience on pipes of all sizes. The proper output voltage is set before shipment and the regulation is thereafter automatic — all functions of the Detector being controlled by a single 'On'-'Off' switch. The patented pulse generator, which makes possible such automatic voltage regulation, is an exclusive feature of the Stearns Detector.

DEPENDABLE SERVICE

The Stearns Detector has been developed through eleven years of field experience and continued research and has become the Standard of the Industry. All major parts of the high voltage generating circuit are custom built for their specific functions and fitted together into an electrical assembly of proved dependability. Users of Stearns Detectors are constantly ensured of receiving equipment in new condition as a result of the rigid shop and laboratory maintenance procedures followed by The D. E. Stearns Company.

*Patent Numbers Furnished Upon Request.

THOROUGH COATING INSPECTION
D. E. Stearns
ELECTRONIC HOLIDAY DETECTOR
SHREVEPORT, LA. U.S.A. — PATD. & PATS. PEND.

The D. E. STEARNS Company

SHREVEPORT, LOUISIANA, U. S. A. CABLE ADDRESS: DESCO

BETTER COATINGS CONSERVE STEEL